Note on Lowering a Large Water Main While in Use.*

BY S. BENT RUSSELL, MEMBER ST. LOUIS ENGINEERS' CLUB

[Read Dec. 3, 1884.]

The pipe that was lowered leads from the stand-pipe of the St. Louis water-works to the centre of the city and considerably more than half the water consumed by the city passes through this pipe at the point of lowering. The grade of 20th street in the two blocks between Benton street and Maiden Lane having been changed by ordinance, it became necessary that the grade of the pipe between these points should also be changed. The pipe is of cast-iron in twelve foot lengths, thirty-six inches inside diameter, with sockets or bells five inches deep. Pipes were joined by the ordinary lead and gasket. A pipe length when full of water will weigh about 11,000 pounds. A deflection of four inches in one pipe length will open or draw the joint about one inch.

The old grade of 20th street had a summit at North Market street which lies half way between Benton street and Maiden Lane, while the new grade has a depression at this point. The greatest lowering required was at this place and amounted to 6.3 feet.

To produce the least possible motion in every joint the final bed of the pipe was laid out in vertical reversed curves. The total fall of each pipe having been determined, the fall for each pipe in any partial lowering was taken with a certain ratio to its total fall. The pipe was lowered in five stages, being one-tenth, two-tenths, two-tenths, one-fourth and one-fourth respectively. Each temporary bed of the pipe was carefully graded under the pipe and of the full width of the trench, leaving under each pipe immediately behind the bell a bench three to four feet long. The benches were then removed with the pick by working them out from the top, not allowing any one of them to be cut away much faster than the others. As soon as the pipe touched the tempopary bed, lowering stopped and a new bed was prepared. On the final bed, blocks eight inches by six inches, and four feet long, were set to grade, and as soon as the pipes rested on them wedges were driven between the blocks and the pipes. Removing the benches in the last lowering occupied about an hour and a half, and nearly a day was taken for each stage of the work. About fifty-four pipes in all were lowered.

The pressure in the pipe was about thirty-five pounds to the square inch, and the pipe was not shut off, but continued supplying the city during the operation. The pipe line, before the work, was slightly distorted by settling. In plan it contained a slight reverse curve. The curvature was made greater as the pipe was lowered the first three stages, and during the last two it was forced towards the straight line again. The irregularities in the profile were corrected gradually as the pipe came down.

No joint was drawn a half inch during the work, and no pipes were broken. No leaks other than a very slight sweating of the joints occurred.

The work was completed Nov. 30th, 1884.

A NOVEL USE FOR NATURAL GAS.—The Homestead Steel Works near Pittsburg have one of H. K. Porter & Co's little three ton locomotive running on their thirty inch track. A few days ago a heavy ingot of steel fell out of the crane into the front end of the locomotive bending the frame. The natural gas used in the works was used to heat the frame without taking any of the machinery apart, clay being used to cover the parts not requiring heating. The damage was repaired in a few minutes while the engine was under steam.

*From Journal of the Association of Engineering Societies.

Steel Ordnance for Russia.

According to the London *Times* very large orders have recently been given out by the Russian Minister of Marine for native-made steel ordnance. The Minister of Marine has commissioned the Oboukhoff Steel Works, near St. Petersburg, to supply for the navy the following steel ordnance: Two 12-inch guns; four 11-inch guns for turret frigates; nine 9-inch guns for monitors; seventeen 6-inch guns for the corvettes Rynda, Vityaz, and Bobr. There are also to be six 9-inch pounders for the latter vessel, and eight smaller weapons for the two former, besides two 2½-inch field pieces for other vessels. Large orders have also been given for ammunition. In past time Russia has been an extensive purchaser of cannon from Essen, but since the Russian Government acquired a large interest in the Oboukhoff Works, cannon on the Krupp system have been manufactured there. These works are situated on the banks of the Neva, and an extensive plant has been laid down by funds provided from the Imperial Exchequer. The largest gun shop is 700 feet long and 70 feet wide, the tools being disposed longitudinally. A 50-ton steam hammer has foundations carried down to a depth of 50 feet. The forge is placed at a lower level than the furnaces, so that the hot ingots are carried by railway to the hammers. The capacity for casting reaches from 40 to 50 tons, requiring 1200 crucibles. A good deal of the steel used in native production is obtained from the Ural Mountains, and is of unexceptionable quality. The puddled steel, which is the basis of Russian gun-metal, is prepared at Perm and the Oboukhoff Works. Hoops for small guns are made from Bessemer steel, the charge being selected from the best Ural and Swedish ores. Siemens-Martin steel is also used for small ingots. The production of steel is receiving a good deal of attention just now in Russia, and the whole of the material for the cannon above mentioned is to be made at the Government works at Briansk, where the steel for the new ironclads Nicolaieff and Sebastopol will be produced. An ironclad, the Katrina II., is now being built at Nicolaieff, and it is for her that the two 12-inch guns first mentioned are to be made. The steel for the small arms factory at Sestrovetsk was made at the works at Zlataoust, where the 12-pounder guns for the Russian artillery are made. Large steel works have also been started at Katal-Ivanova by Prince Belozeusky, and to these works the Government has given an order for steel rails, sufficient it is said to keep them employed for years.

Efflorescence on Walls.

BY C. H. SMITH.

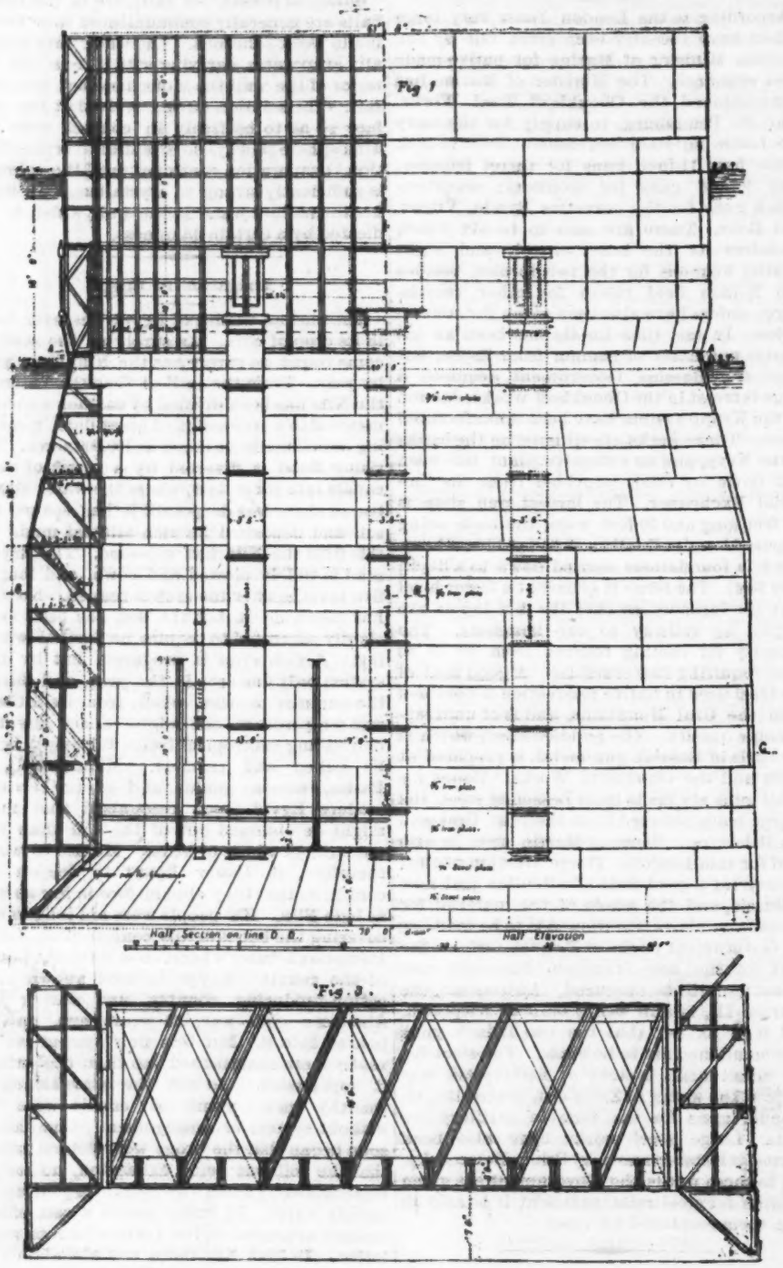
Under ordinary circumstances, it is scarcely possible to get rid of the various saline or deliquescent substances that have once been admitted into the walls of a building. The fixed alkalies (potash and soda) may probably be considered imperishable, no length of time can injure them; they may effloresce, or rather they may crystallize on the surface of a wall and totally or partially disappear again and again, as often as a change in temperature or of dryness or humidity takes place. These changes may be daily, or the salts may remain inactive during ages, and from some favorable cause a crop of crystals may be produced as vigorously as if the wall had recently been finished. The only way to abate the evil is to brush off the crystals whenever they appear to be in the most flourishing condition. If potash has been introduced into the walls either from the putrefaction of animal or vegetable substances, or from other sources, however thick the wall may be it will make its way to the surface, and then absorbing nitrogen from the atmosphere, which contains seventy or eighty per cent. of that substance, "nitrate of potash" or saltpetre is produced. Salts are generally communicated to a building in weak solutions. The water very gradually evaporates, carrying with it from the interior of the wall the molecules that compose salt. The solution having arrived at the surface so as to be freely in contact with the atmosphere (always so essential to crystallization,) evaporation continues until the solution is sufficiently strong to crystallize, still leaving the mother water in the wall, which is indicated by a certain dampness.

Irrigation in Egypt.

The ancient wealth of Egypt has ever been in its crop of corn. As surely as the seasons come round, so surely has the Nile risen year by year. From the earliest time the Valley of the Nile has been divided by earthen embankments into a succession of great flats, measuring occasionally as much as 100,000 acres. The rising flood is diverted by a series of short canals into these flats, where the water stands two or three feet deep until it has soaked the soil and deposited its rich alluvial mud. By this time the Nile has subsided. The drying mud is rudely plowed and sown, and four or five months after the crop is reaped. No rain has fallen on it, but the soil has been sufficiently saturated to require no further watering. A rich crop is produced, but by this system only one crop in the year, and during the summer months, when, from its latitude and temperature, one might expect Egypt to be yielding subtropical fruits, the empty fields lie baked and parched. Muhammed Ali Pasha, whose genius and energy created modern Egypt, soon recognized that more might be obtained out of the soil than this one crop of wheat or beans. He set to work, therefore, in Lower Egypt to deepen the canals, so that they should flow in low as well as high Nile. His people were not long in discovering the benefits this conferred on them. Pumps and water wheels soon lined the banks of the canals. Egypt became known as a cotton-producing country, and during the American civil war, 20 years ago, wealth poured into it. But this new system was a vastly more complicated one than that which it superseded. To suit the convenience of wealthy men, numerous canals were cut without system or arrangement. Complaints soon began that the crops were deteriorating, that the soil was being exhausted, no longer replenished by lying two months a year under muddy water. In many places a salt efflorescence appeared on the surface fatal to vegetation. In high Nile there was abundance of water for all, but in low Nile, just when the cotton crop wanted it most, there was least to be had, and then the peasant's poor little patch had every chance of being withered, while the pasha's broad acres were flourishing. Worst of all, this great network of canals was nearly filled with Nile deposit which had yearly to be removed, and an unpaid army of 60,000 peasants was employed for about half of every year effecting the necessary clearances. In the long, narrow valley of Upper Egypt, except in one portion the old Pharaonic system of irrigation still prevails, and here the Egyptian has little to learn. In the delta the new cultivation with perennial irrigation is practiced, and, in this, the richest part of the country, Lord Dufferin soon saw the gravest reasons for anxiety. A system has been created which the people did not understand. Ignorance of the most ordinary rules of engineering, indolence, and corruption were fast destroying the country.—*The Nineteenth Century.*

To Extend. At the recent annual meeting of the Pittsburg, Cleveland and Toledo Railway, the building of a line from Youngstown to Sharon, Pa., connecting with the Sharonsville Railway, was discussed, and it is said the work will soon be begun.

FIG. 1.—FORTH BRIDGE: DETAILS OF CAISSONS FOR THE QUEENSFERRY PIER.



THE FORTH BRIDGE.

From time to time we have published accounts of the progress of the Forth Bridge, and in the present issue we give illustrations of the caissons for the Queensferry Pier. It will be remembered that there are three main piers, the Inch Garvie Pier, and the Queensferry Pier, and upon each of these there is built a huge cantilever stretching both ways. The Fife Pier stands between high and low-water mark, and is separated by a span of 1700 feet from the Inch Garvie Pier, which is partly founded upon a rocky island in mid stream. Another span of 1700 feet carries the bridge to the Queensferry Pier which is at the edge of the deep channel. The total length of the viaduct is about 1½ miles, and includes two spans of 1700 feet, two of 675 feet, the shoreward halves of the outer cantilevers, fifteen of 168 feet and five of 25 feet. Including piers, there is thus almost exactly one mile covered by four main spans, and half a mile of viaduct approach. The clear headway under the center of the bridge is 150 feet above high water and highest point of the bridge is 360 feet above the same datum. The contract was let to Messrs. Tancred, Arrol, and Co., on December 21, 1882, for 600,000*l.*, and work was commenced in the following month.

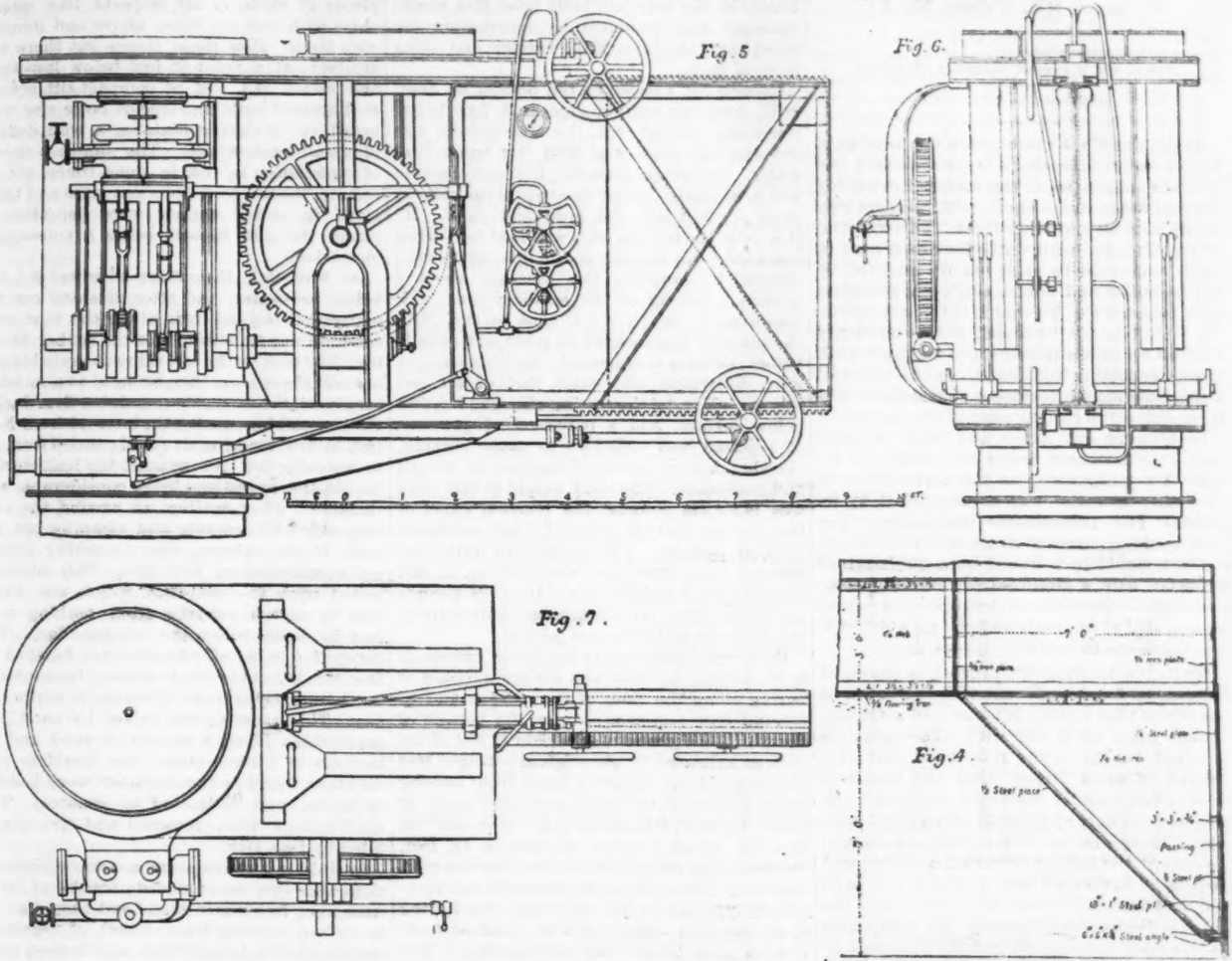
Each of the main piers comprises four columns carried down to the rock on the boulder clay. Three of the Fife columns are completed; and the remaining one is in progress; at Inch Garvie one pier is complete, one is in progress; while at Queensferry the work on the caisson is advanced. All the pneumatic caissons will be filled with concrete up to low water mark of a mixture having a crushing strength of 50 tons per square foot. Above low water the cylindrical piers, which are 49 feet in diameter at the top, 55 feet at the bottom, and 36 feet high, consist of the strongest masonry, the hearting being flat-bedded Arbroath stone, and the facing, Aberdeen granite. In each cylindrical pier there are 48 steel bolts, 1½ inches in diameter and 24 feet long, to hold down the bedplate and superstructure of the main spans. One of the Fife piers was built by aid of a timber and clay cofferdam, and one by means of a half tide dam. At Inch Garvie much of the work of the shallow piers had to be done at low tide under great difficulties.

The Queensferry Pier consists of a group of four cylindrical caissons 70 feet in diameter at the bottom edge. Figs. 1, 2, 3, and 4 show the details of construction of the south-west or shallowest caisson. Owing to the special conditions of the site the work differs in some respects from ordinary pneumatic caissons. The bed of the Forth at the Queensferry Pier is of very soft mud for a depth of from 20 feet to 35 feet, when the boulder clay is reached, the surface of both the mud and the clay falling sharply towards the 200 feet deep channel between Queensferry and Inch Garvie. The caissons had to be floated out and sunk about one-third of a mile from shore in an exposed seaway. To facilitate operations the caissons have double skins (Figs. 1, 2, and 3), 7 feet 6 inches apart and vertical bulkheads between the skins. By filling the space between the skins with concrete to varying heights, the irregularity in the level of the bottom, and the hardness of the mud could be to some extent compensated for, as the weight brought upon the cutting edge (Fig. 4) of the caisson could be regulated as desired. Iron being very cheap a liberal use was made of it in conjunction with concrete where masonry or brickwork might have been employed. Strong lattice girders, (Fig. 3), and cross girders stiffen to the required extent the roof of the working chamber. These girders are subject to a heavy bending stress upwards and downwards owing to the tide, the range of which is about 20 feet. Thus if sufficient concrete were filled over the roof to balance the air pressure at mean tide level then at high water the excess of air pressure, unbalanced by the weight of concrete, would obviously be that due to the half-tide difference of height, and at low water, similarly, the excess weight of concrete would be of the same amount. There would thus be a force of more than 1100 tons tending to bend the girders downwards at low water and upwards at high water.

Two shafts 3 feet 6 inches in diameter, with air-locks for passing out the excavation, and one shaft with double air-lock for the men, are provided together with ejector pipes for the mud, water pipes, supply pipes for the concrete, and other conveniences. Figs. 5, 6, and 7, show the former locks, which are of somewhat special construction and have worked extremely well in practice. The lock proper forms a simple continuation of the shafts, and there are two sliding doors placed horizontally with sufficient space between them for the skip of excavated clay or boulders. An internal drum fixed on one side of the lock is driven by an external pair of engines fixed to another side of the lock, the shaft passing through a stuffing-box. A pair of small hydraulic rams work the sliding doors, hand gear being also provided though never worked, and interlocking arrangements analogous to those used with railway signals, make it impossible for both doors to be operated together.

When a skip has been filled below, a signal by air whistle is given and the engineman on top of the caisson starts the winding engine. In little more than a minute the skip will be at the top of the 70 feet shaft, an index needle informing the engineman of the fact. The latter then stops the engine, closes the lower hydraulic sliding door, reverses the engine a stroke, and the skip rests on the closed door. He next lets the compressed air escape from the lock and then opens the upper hydraulic slide. An attendant immediately jumps down on to the skip, unlocks the hoisting chain, and hooks on the chain of a steam crane, which lifts the skip and swings the contents into the sea. About three-quarters of a minute is occupied in passing the skip through the lock, and two or three minutes in emptying and returning

FIGS. 4, 5, 6, 7.—FORTH BRIDGE: AIR-LOCKS FOR CAISSONS OF THE QUEENSFERRY PIER.



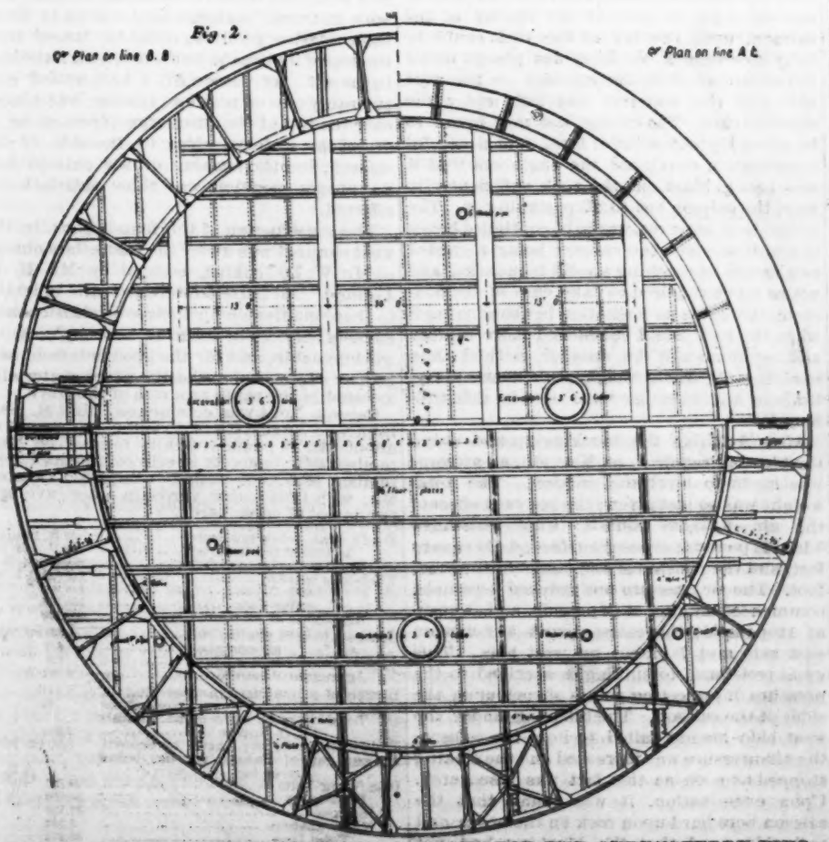


FIG. 2.—FORTH BRIDGE: PLANS OF CAISSONS FOR THE QUEENSFERRY PIER.

it, during which time a duplicate skip is being filled below. The two air-locks were designed by the engineers to pass out easily an amount of excavation equivalent to a descent of 1 foot per day of the 70 feet diameter caisson, but owing to the extreme hardness of the clay the rate has not hitherto exceeded 8 inch per day, which under the circumstances is very good work. Picks and shovels made no impression on this material, which had to be attacked by hydraulic spades having a ram fitted to the cutting blade and abutting against the roof of the working chamber. At the present time the sinking of two of the caissons has been completed, another is in progress, and the last of the group is being floated into position, as some weeks ago it filled with water from some cause and slipped forward on the mud about 15 feet.

In going through the mud and silt, the material is blown out through pipes by the compressed air in the caisson assisted by a due supply of water from a closed tank elevated some feet above high-water level. To guard against too sudden a descent of the caisson in the soft mud the engineers designed heavy cross frames of timber to divide up the 70 foot space and distribute the load, but the sub-contractor who undertook the sinking removed these frames. Occasional lurches and sudden descents have occurred, but the men employed have great experience in caisson sinking, and appear little disturbed by such incidents.

When sunk to the full depth, which, in the case of the north-west pier is 96 feet below high water, the caisson is filled with concrete up to low water level, and the remainder of the pier is built of solid masonry under the protection of a wrought-iron temporary caisson. —*London "Engineering."*

Caisson-Sinking at the B. & O. Bridge, Havre de Grace, Md., (Caisson No. 4.)

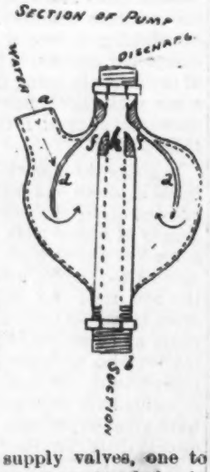
Written for ENGINEERING NEWS.
BY COL. WM. M. PATTON, ENGINEER IN CHARGE.

(*Continued from page, 229.*)

At Caisson No. 4 there was a depth of $28\frac{75}{100}$ feet of water; excepting a layer of about 3 feet of clean, sharp sand, the material overlying the rock was composed of a stiff, compact clay or silt, both air and water-tight. This material when combined with water formed a mud or slush and could be most readily removed by the water-jet and pump, and both processes were resorted to. To enable it to pass out by the "blowing out" process, it was necessary to cut it up with a shovel while mixing it with the water coming from leaks. In this material it was possible to excavate a considerable distance below the cutting edge of the caisson.

In blowing out water and sand, or sand alone, the discharge would be continuous for a greater or less time, but the blowing out of this silty material was accomplished by irregular and intermittent discharges. The pipe would apparently choke up for a moment, and this would be followed by a discharge of material, with a disagreeable, gurgling noise and violent vibrations of the pipe; this would be repeated at intervals and the greatest care was taken not to feed the pipe too fast.

While the blowing-out process is the most economical for a sandy material, the writer is convinced that a pump is better and more convenient when silt is met with. The principle involved in the latter process is that of a column of water forced down one pipe and flowing into another through a contracted orifice, and discharged upwards with a great velocity This ascending column produces a partial vacuum at the bottom turn and a consequent suction is developed which draws the sand and mud from below and this mixed with the water is discharged at the top. The pump used on this work was pear-shaped (See Illustration) about 15 inches in diameter and length, and arranged as shown in the sectional figure annexed. Water was supplied by a Worthington pump and entered the sand-pump at *a*, impinging on the inner casing *d* it is divided around and escapes under this lining and upwards through a narrow annular space at *f*. The size of this space can be adjusted by turning the pipe *b*, which lowers or raises the conical-shaped rim of steel *k* which forms the upper end of the suction pipe. The inner lining splits the water up, as it were, and enables it to pass out by the annular opening more freely than it would if the supply was simply directed in one stream to that point. To prevent the too rapid feeding, or the entrance of lumps which might choke the pipe, a strainer is put on the bottom of the suction; this was simply a short piece of pipe, plugged at the end, and with a series of $\frac{1}{2}$ to $\frac{3}{4}$ inch holes bored in it.



To operate this pump, one man was required to regulate the water supply valves, one to handle the jet-hose, one to keep the holes in the strainer open, one to continually stir up the water and mud, and other men, variable in number, to shovel the material from a greater or less distance to the suction pipe, where it was further cut up and mixed with water. Owing to a too great concentration of the pipes around the supply shaft, in this caisson, the material had to be handled several times; in the caissons built later this inconvenience was remedied by distributing the pipes along the sides of the caisson and using more of them.

Caisson No. 4 rested on the bottom on Sept' 28th, with the cutting-edge 28.78 feet below low-water; by Oct. 3rd, the false-bottom was out and the edge was 32.08 feet below low-water. The weight of timber, iron and concrete was 5,687,946 lbs., under this weight the caisson sunk $3\frac{3}{10}$ feet into the mud and sand. By Oct. 11th, the bottom edge was 41.81 feet below low-water, the sinking up to this time being effected by lowering the pressure about 3 pounds. Setting of the masonry was now commenced, and from this time to Oct. 18th, the pressure was lowered as much as 6 pounds before sinking commenced; the compressors were delivering 458½ cubic feet of air per minute. Nov. 1st the cutting edge was $57\frac{5}{10}$ feet below surface, and a reduction of pressure of 1 pound was sufficient to cause sinking, showing a very close adjustment of weight and resistance. The total weight at this time was 10,958,448 pounds; the bouyant effect of the air was 9,014,907 pounds; total resistance 1,943,541 pounds. The surface of crib and caisson below river bed was 6,306 sq. ft. and the calculated resistance was thus 308 pounds per square foot; the compressors were delivering 372 cubic feet of air per minute.

Rock was discovered 1½ feet below caisson at S. W. corner; the rule was always adopted of boring along the sides of the caisson and at intermediate points as soon as the bottom of the working chamber was within 10 feet of the rock as indicated by the original borings; this was to avoid any danger arising from coming down unexpectedly upon any high point of rock. On Nov. 8th, owing to a "blow-out" on Nov. 5th, which lowered the caisson $1\frac{2}{10}$ feet, we found the caisson hard down on the rock at several points along the east side, but without any damage to the structure. On boring along the west side rock was found at from 4 to 5 feet below the cutting-edge. The total weight at this time was 11,426,023 pounds, and in order to prevent the tipping of the caisson, until the lay of the rock could be fully ascertained, blocking was placed under the shoulders of the cutting-edge on the west side and the material was left under the central truss. The caisson was now found to be about $15\frac{3}{4}$ inches out of level, and a careful examination convinced the engineers that it was best to blast out the rock sufficiently to level the caisson but to stop sinking it. The excavation, however, was to be continued below the cutting-edge; the caisson being regarded as a means of reaching a solid foundation and not as a box required to take care of the concrete, there was no hesitation in abandoning it when the rock could be reached more rapidly and economically by another method than lowering the whole weight; when necessary, timbers and sheeting were used in this sub-foundation.

After finishing the blocking-up and doing the blasting required, on Nov. 9th, an attempt was made to level the caisson. The total weight was as last given; the bouyant effect of the air, 8,263,665 pounds; total resistance 3,162,358 pounds; exposed surface, 6,460 square feet, and the resistance 489½ pounds per square foot. The air pressure was reduced 3 pounds, commenced sinking at 22 pounds, and stopped at 14 pounds; the caisson sunk 5 inches on east side and 7 inches on west side. This great resistance to sinking is ascribed to the pressure of projecting points of rock upon the sides of the caisson. The blocking under the west side having failed to hold the caisson, the air-pressure was increased and the sinking stopped as soon as this fact was discovered. Upon examination, it was found that the caisson bore hard upon rock on the north and east sides, and that the blocking had not crushed but had *settled*; the investigation showing that this blocking rested upon small pieces of stone in all respects like quarry chips with well-cut stone above and mingled with them. How these stones got there is a mystery; at a point 60 feet below low-water and under $31\frac{3}{10}$ feet of compact silt, several well dressed building stone of large size were found, one of them containing a well defined plug-and-feather hole. The simplest theory of explanation is, that in some times, not far remote, the bed rock here was bare and these stone in some manner were deposited in place, the silt deposit being a subsequent formation.

On Nov. 15th, the cutting-edge was $60\frac{1}{10}$ feet below low-water, and after cleaning out the material to the bed-rock, along the west side, concrete was substituted for the timber blocking. The rock on the east side was again blasted out and the caisson then brought to a satisfactory level, the west side remaining firm during the last sinking; during the interval from Nov. 16th to Nov. 22nd, the air supply varied from 551 to 368 cubic feet per minute, the leak during the blasting operations being considerable and variable. After sealing up around the cutting-edge with concrete and cleaning out the body of the caisson, the concreting proper was commenced on Nov. 29th. This concrete rested upon the bed-rock which was irregular in surface varying from nothing to 5 feet in depth below the cutting-edge. The concreting in the air-chamber was finished by Dec. 7th, 572 cubic yards having been placed in position, an average of 63½ cubic yards per day. This concrete was mixed by hand, the proportions being 1 cement, 2 sand and 12 barrows of broken stone; the boulders and cut stone found in the chamber were bedded in mortar and estimated as concrete. The shaft-linings were removed and the shafts filled by Dec. 11th.

In sinking these caissons no serious obstructions were ever encountered; trunks of large trees were frequently found and they had to be cut out, causing delay; layers of vegetable matter, chiefly small twigs and leaves, were met with, and in one instance an upright tree, with its trunk, branches and leaves in about their relative position, could be traced from the top of its boughs to its roots, all imbedded in the silt. As caisson No. 4 had settled considerably out of position, boxing was placed over the top of the discharge pipes so as to divert the material close to the side of the caisson, and the pushing of the caisson into its proper position was thus satisfactorily effected.

The construction of the foundations in the west channel was under the immediate charge of Mr. W. D. Jenkins, assisted by Mr. H. F. Lofland. All parties interested are indebted to these gentlemen for their conscientious and efficient services in securing thoroughness of workmanship, and for the good judgment and proper exercise of authority which materially assisted in the rapid progress of the work.

Caisson No. 4 was commenced May 24, 1884; launched August 8th, with launching weight of about 652,070 pounds; finally located on September 25th; concrete in crib commenced September 16th; concreting completed October 9th, with 1,604 cubic yards, in place; average per day of 67 cubic yards.

Depth sunk below low-water	59 ft. 10½ in.	
" to lowest point of rock	65 " 3¾ "	
Total material excavated	159,588 cu. ft.	
Timber in caisson	316,689 ft. b. m.	
" " crib	143,993 " " "	
" " coffer-dam	103,518 " " "	
Aggregate of all timber	569,200 " " "	
Concrete in crib, shafts, etc.	1,635 cu. yds.	
" " air-chamber	631 " "	
" below cutting-edge	126 " "	
Aggregate concrete	2,392 " "	
Barrels of cement used in concreting	2,148	
" " " grouting	94	
Total barrels of cement (mainly "F. O. Norton")	2,242	
Yield of concrete per barrel of cement	1.06 cu. yds.	
Average rate of sinking per day below river-bed	⅛ ft.	
Iron Screw-bolts	32,881 lbs.	
" Drift-bolts	40,909 "	
" Spikes	11,730 "	
" Cast-washers	3,392	
Total Iron	88,912	

(TO BE CONTINUED.)

The Artificial Filtration of Water.*

BY H. T. TURNER.

The word artificial has been here introduced in order to avoid a possible confusion of this subject with that of the so-called "natural"-filtration, better and more reasonably known as "percolation." And, before discussing the question of filtration, it will be well to be prepared to confine the ideas expressed by the term within such limits as a good theory may dictate, and as the best practice attain at the present time.

The degree of purity that a chemist requires in water is not aimed at; yet there are filters to-day in operation which more than realize the intention of filtration, when the word meant simply a straining through "felt." It is essentially a mechanical operation of separating water from solid matter in suspension partly by actual interception of the grosser matter, but mainly by attraction and adhesion of the more finely divided particles to the interior surfaces of the filtering medium during the percolation of water. To help to appreciate this action, it may be observed that Humber estimates the available adhesive area in a cubic yard of sand, of cubes 1-20th of an inch in diameter, at 22 superficial yards. The importance of taking this view of the action is the author considers, not enough recognized by those in charge of filtering processes. And, in adopting it, one should note the distinction between this effect and the chemical purification of water, which does undoubtedly take place to a greater or less degree in all well arranged filters; a secondary result, useful, but, in the present state of our science, not worthy of being confidently accepted as a constant function of those processes.

The material most extensively used for filtration is sand, the most desirable quality of which seems to depend entirely upon the view taken of the action reviewed in the foregoing. That straining only is aimed at very often is clear from the mode of working many filters. It is not an uncommon practice to allow the turbid water to stand on the filter-bed until the sediment thrown down is thought by the superintendent sufficient to perform the work of a fine strainer. The sand to an average depth of 3 feet is useful in such a case only to support this film of mud, and as the latter keeps growing in thickness the "head," or pressure, must be proportionately increased, with the obvious result of soon detaching the lowest particles of this deposit, and forcing them through along with the *clear* water. The first cause of this is extreme coarseness in the sand; and to illustrate the point the author will draw your attention to a sample of washed sand, as used in the filters of one of our English cities, which are worked much in the manner described. Now filtration is designed, in the first place, to render water at least clear, although actual color may be reduced by an oxidation of the vegetable coloring matter in solution. This is promoted by the action of the facets of the sand in rendering dissolved oxygen to the organic matter, and also by combination of this latter with the oxygen retained in the interstices of the sand.

The arrangement of an ordinary filter-bed, through which the water passes downwards, is pretty generally familiar. It is a water-tight basin, the floor of which is covered to a depth of two or three feet with large stones, disposed so as to form drains to the outlet. Above these stones are layers of gravel, each of about 6 inches in depth, and diminishing in size until sufficiently fine to carry the filtering sand, which forms, on an average, a layer about 3 feet deep. The design includes—the "selection of the sand" and its "depth," the "rate of filtration," and the "depth of water over the sand.

The degree of fineness of the sand, and the rate of filtration usually expressed in inches per hour, are somewhat dependent one upon the other but the limits within which selection of either may be made are so narrow, that it may be accepted as a rule that the outside rate should be 6 inches per hour, and that the sand should be sharp, of uniform size, coarse rather than too fine (between 1-25 in. and 1-75 in. in diameter of grain), and free from any soluble minerals. Experience shows that a higher rate washes the silt through, and very fine sand has the disadvantage of soon becoming clogged on the surface. So it becomes a nice question of economy whether, in dealing with a very turbid water, the rate should be lessened and the area of the beds proportionately increased, or finer sand should be used and a higher "rate." For it will be noted that any gain in area from a high rate and fine sand, often scraped and washed, is modified by the extra area demanded for spare filters to be alternately worked during these operations.

The lowest rate of filtration of river water in England is about 3 inches per hour, so that the available area of the beds may be estimated at between 1500 and 3,000 superficial yards for every million gallons required per 24 hours, and to this may be added one third as an allowance for spare filter room.

It is usual to provide a depth of sand of between two and three feet, and when the desirability of a very uniform movement of the water is considered, this does not appear to be excessive. But the total depth of material, including the bottom drains, varies in English practice between 8 feet and 3 feet 6 inches.

Great depth was formerly thought necessary to prevent a tendency of the water to percolate irregularly through the sand in the neighborhood of the drains. But the most modern form of construction is a false bottom of bricks or tiles, laid close, supported off the floor of the filter bed by rows of bricks on edge, about five inches apart. This carries a layer of six inches of shells or fine gravel, upon which again is spread the filtering sand. The economy of construction is thus very great, the ordinary depth being reduced by one half, whilst the results appear to be quite good.

The depth of water over the sand is a point about which much difference of opinion seems still to exist among engineers. In England it varies between seven feet and nine inches. Now, in very cold climates either the filters must be covered, or several feet of water should be kept constantly over the sand, to prevent the frost from penetrating it; and even then the breaking of the ice round the sides, to prevent thrusts, demands a considerable share of the daily attention. But where no such reason exists, the practice of maintaining a great depth of water on the sand virtually combines a filter and settling pond, and largely increases the cost of construction. Whilst the advantage claimed of thus keeping the water cool during its passage, and free from confervoid growth, seems only equal to the disadvantage of exposure to the sun for a proportionately long period.

The "head" of water under which a filter is to be worked, is a point about which, the author thinks, clear notions do not always exist. It is entirely ruled by the "rate," and is equal to the difference of level of the water-surface in the filter and that in the clear water well, less a deduction for loss by friction through the sand. Of course, as the sand becomes fouled this loss increases, and the head is maintained by lowering the water level in the clear water well, or, what is equivalent to that, opening the outlet valve. With sand in good condition, a "head" of from one to three inches should cause a proper rate of flow. It may be observed that if the clear water level be allowed to fall *below* the surface level of the sand, there will ensue a liability for the water to force its way irregularly through those parts of the sand where the clogging offers the least resistance. Therefore, it would almost seem to be well rather to maintain the "head" by raising the water level on the sand. That this is not the actual practice the author is aware, and it would involve special modification of the overflows. But then the results are in many cases far from satisfactory. With any ordinary water a good system of filtration should reduce the solids in suspension to less than 1 part in 100,000. That is without reference to carbonate of lime, whose presence to as high a degree as 15 or 20 parts in 100,000 is deemed unobjectionable by many, and whose amount is estimated by a separate scale.

Into details of construction the author cannot propose to enter now, but would notice one or two leading features.

The old filter-beds are generally puddle-lined, with sides battered at 1 to 1½ inches, or thereabouts; but the more modern kind have cement concrete floors, and concrete, or brick in cement side walls, very slightly battered (about 1 inch in 1 foot.)

There is some danger to puddle when a filter is run dry, and those with sloping sides possess the disadvantage of deriving no benefit from all that area of sand overlying the slopes. It has been customary to provide for the escape of air during the charging of filters, by means of pipes led up from the top of the drains to above the overflow level. The precaution may be advisable in small filters where it is possible to supply the water very fast, but in those of large size, if charged as they should be, upwards, from the clear water tank, it seems unnecessary, and, further, a creep of water may be induced down the sides of these air pipes. But with the most perfect construction, the efficiency of any filter will still be dependent on the attention and the care in cleansing bestowed upon it. The cost, too, of scraping, washing, and replacing the sand constitutes almost entirely the working expenses, and it is surprising to find how little effort seems hitherto to have been made in this respect, towards reducing manual labor by mechanical appliances.

This difficulty is met in some few cases by what is termed "reversing the filter." Thus, at Zurich, it is the custom to cleanse the beds by forcing the water through them upwards, whilst men in rubber clothing stir the sand with forks, releasing the dirt, which is washed down the overflows. A fault of this system lies in the fact that water under the necessary pressure will blow through the sand irregularly, and leave it in bad condition for filtering. Then to use *filtered* water for hte purpose would be out of the question, and *fiunltered* water must naturally leave a quantity of sediment in the lower parts of the sand. Sand washing apparatus may be said generally to take the form of a trough or shallow box, with either a perforated or grid bottom. Through this, water is forced upwards into the mass of sand in the trough, releasing and floating off the collected sediment, as the sand is kept stirred about by men with shovels or forks.

A more advanced form of machine consists of an inclined metal cylinder, revolving on a perforated pipe as axis. The dirty sand is fed into this cylinder at the higher end, and in travelling down is exposed to jets of water under pressure, supplied through the perforated pipe. The sand is gathered from the lower end into troughs, whilst the dirty water flows away down drains provided for it. The worst of this arrangement seems to the author to be that at the lower end of the cylinder, where the sand should be delivered clean, it is exposed to the wash of the dirtiest water.

*Read Feb. 27, 1884, before the Liverpool Engineering Society.

Besides sand, however, there are several filtering materials in use which aim further at the chemical purification of water, though for engineering purposes they can hardly be said to have yet passed the experimental stage. Firstly, "animal" and "vegetable charcoal" in various forms, one well-known as "silicated carbon." The chief advantage claimed for these is their property of removing dissolved organic matter, through dissolved oxygen, by a sort of catalytic action.

And here it may be urged on behalf of the much abused house-filters of the charcoal class that there is often a misconception as to their action. The straining that should be necessary is to be performed by the sponge or sand, which should be often cleansed and occasionally renewed; whilst the intention of the interior charcoal) of which it is sometimes complained that it cannot be washed, is purely chemical, and when its action ceases it requires to be re-burned, or, as is found in practice more economical, to be *renewed*.

Then iron in two forms should be noticed. One, known as "Spencer's Carbide," held to consist mainly of magnetic oxide of iron $Fe_3 O_4$); the other, "Spongy Iron," not differing from it much in constitution. A detailed description of the use of this latter at the Antwerp Waterworks may be found in Min. Proc. Inst. C. E., vol. lxxii. The comparative analyses of the water before and after the process exhibit remarkable purifying properties in this substance.

In 100,000 parts	Before	.. .242	combined nitrogen.
	After	.. .055	" "

And a reduction in total hardness from 11.5° to 8.4°. And chemists pronounce "spongy iron" to have a characteristic effect of destroying bacterial life in water, whereas carbon, on the contrary, is said to be favorable to its developement.

All these processes are expensive, and the spongy iron principle involves an exposure to the air after filtration, in order to further oxydise any dissolved ferrous oxide, and subsequently a *second filtration* through sand, to separate the ferric-oxide thus formed. Now, whilst the action of these substances upon organic matter, and upon low organisms may be very marked, they are yet no rivals to sand as filtering media. Their use is to purify organically impure water, and works for their use are costly in construction and in maintenance. For although we regard chemistry as a very exact science, and biologists speak confidently upon the nature of low organic life in water; though chemical and microscopic examinations of the same water, at various times, may be of immense value to those who can interpret their results intelligently; yet, inasmuch as there exists no universal standard of purity and wholesomeness, we cannot be prepared to judge the merits of potable water by its analysis, without entire knowledge of its proximate source. Nor is it desirable to suggest supplying for domestic purposes a palatable water chemically purified from a foul condition. Such a necessity may arise, but its discussion is without the scope of this paper.

Doubtless, there is some degree of chemical action in an ordinary sand filter, both of oxydizing organic impurities, burning them away as it were in the manner noted, and also softening the water through the escape of carbonic acid induced. But such results should be regarded only as useful accidents of the system and *not reliable* in any certain degree. The true intent of artificial filtration being, not to produce chemical purity in water, but to separate from it the solid matter held in suspension.

MAP OF NORTH CAROLINA.—Col. A. W. Shaffer is now reading the last proof of his map of North Carolina' He has we understand, completed all the township boundaries except that of the county of Madison. The Colonel's map will be the best map of North Carolina that we have ever had.

The Metric System.

TO THE EDITOR OF THE NATION:

Apropos of some recent opposition to the introduction of the metric system into the United States, I should like to say a few words which would perhaps better find a place in a technical journal, were it not that the subject is one which is now before the tribunal of the lay public; the technical bodies of the United States being so overwhelmingly in favor of the system that the distinguished opponents of it (and there are a few such left) write rather bitterly, and with an evident sense of working for a lost cause, when they appear against it.

A recent article from one of them says: "One of the objections to attempt to introduce it here is that improvements that can be made in our present system (so called) [I say heartily Amen to the "so called"] are thereby delayed, such as the use of the ton of 2,000 pounds and cental of 100 pounds." I hope the objections will continue until the ton of 2,205 pounds (1,000 kilograms) takes the place of that of 2,240 and the center of 220 pounds (100 kilograms) supplants the hundred weight (!) of 112 pounds. The same writer calls us to reflect upon its "whimsical, unspeakable, polysyllabic Græco-Roman nomenclature." Something over ten years between my two visits to this country have sufficed to carry over what he would find a rather dull peasantry to the polysyllables referred to; which consists in lineal measures, of the millimetre, centimetre, metre, and kilometre, in place of sixteenths, thirty-seconds, and sixty-fourths of an inch, inches, feet, yards, and miles. In weights, grammes, kilogrammes (generally called kilos,) and tonnes, are used instead of grains, ounces, pounds, and tons, and in liquid measure the litre has practically supplanted gills, pints, quarts, and gallons. It is divided for ordinary purposes (*e. g.*, beer drinking!) binarily, into halves and quarters.

The same article says: "What the iron heel of a military despotism may have accomplished with the pauper laborers of an effete European monarchy is not worth a tinker's dam * * * as a precedent for a free people." I am inclined to think the said iron heel did not have to grind very hard on the railroad men of Germany in this instance, in spite of Mr. Coleman Seller's statement that they told him they were forced into the system: since it substituted a single decimal system for some 12 or 14 duodecimal ones formerly used, with all of which they had to be familiar on account of car interchange.

The same opponent of the metric system exhibits the tonnage of the world as given at the Meridian Conference—

	Tons.
Tonnage controlled by Greenwich Standard	14,000,000
" " " Paris	1,735,000

—as a proof of the greater extent of the English system of measurement. He does not compare the relative disturbance to this branch of trade to be produced by changing the 2,240 and 2,205 pounds tons in the table to his 2,000 pounds tons, with that produced by changing the English and American tonnage from the 2,240 pounds English to the 2,205 pounds French ton, with the advantage, in the latter case, of having the collective tonnage on a decimal system.

There are some points in the metric system which has been suggested to me by the ladies of my family—who after a short experience with it are its enthusiastic advocates—which I do not remember to have seen mentioned before. These are, the facts that our dry-goods houses are put to a good deal of extra trouble and expense in changing the metre folds of imported goods into yards, and that in selling very expensive goods by the inch with prices by the yard the figuring is rendered very complicated: whereas in selling by the centimetre nothing can be simpler than the calculation based on the metre price.

The old objections to the introduction of the metric system on the score of its throwing out of use great numbers of tools has always seemed to me unfounded; and I am confirmed in this view by finding that German shops use quantities of English tools, which they call 1 *zoll*, 2 *zoll*, etc., as being convenient names. So we can continue to use tools of the present sizes, continuing to call them 1 inch, 2 inch, etc.; it being understood that the dimensions of such tools are a given number of millimetres, whenever it is necessary to state them exactly.

A curious instance of the inconvenience of our subdivision into sixteenths and thirty-seconds is the general practice of mechanics of calling 25 thirty-seconds, for example, three-quarters and a thirty-second, as giving a better idea to the mind of what proportion of an inch it is. It would never occur to a mechanic under the other system to say 2 centimetres and a millimetre instead of 21 millimetres, since the very form of the figure shows him that the dimension is one millimetre over 2 centimetres.

The battle of English and French wire gauges has nothing to do with the metric system, since the English dimensions are very complicated when expressed in inches, and no more so in millimetres.

To our friends who are in the habit of calling their Government lands eighties or forties the same remark applies as to tools: they can go on doing so—only, when they want to express the area exactly, they would do so in *ares* instead of acres. The name of eighty or forty for a Government subdivision refers to the nature of the division of the section, and rarely expresses the exact area contained in the piece in question.

We who believe in the metric system do not wish to have it imposed upon those of contrary belief, further than to have Government officers transact their business with metric measures; in hoping for which, however, we do not disguise the hope that the country will go over to that system en masse within ten years after its adoption by Government offices.

Yours respectfully,

W. HOWARD WHITE.

The Nation, March 5, 1885.

Chinese Iron-Foundries and Rice-Pan Casting.*

As a notable example of the patient plodding industry shown by the Chinese, may be instanced the manufacture of the very thin cast-iron rice-pans which may be seen in any cook-house in Hong-Kong. The principal seats of this industry are at the towns of Sam-tiu-chuk and Fatshan. The iron used is obtained by smelting magnetic oxide. The ore is broken up and smelted with charcoal in a very primitive smelting-furnace some eight feet high. The cupola is cone-shaped, having its apex at the bottom. The single tuyere pipe is of earthenware, the opening for the emission of the blast being inclined downwards. The furnace itself is of earthenware, strengthened by hoops and longitudinal straps of iron. The whole is lined with clay several inches thick. The internal diameter at the bottom is about two feet, and at the top three feet and a half; the inside depth being about six feet. The blast is produced by a rude bellows, formed of a wooden box five feet long, by three in horizontal, and a foot and a half in vertical section. This box is divided longitudinally into two compartments, each eighteen inches square in vertical section. In each of these compartments a piston works, the valves being so arranged that one piston is effective in the up, and the other in the down or return stroke. As there is no air-chamber, the blast is not perfectly continuous. The fuel used is charcoal; and the furnace, being first heated by

*From the Journal of the Iron and Steel Institute.

starting a fire with fuel alone, is then filled up with alternate layers of charcoal and ore in small fragments. The blast is urged, and, after a sufficient time has elapsed, the molten metal is drawn off from a tap-hole at the bottom, and cast into ingots. These, when intended for export, are afterwards reheated in an open forge.

For making the very thin rice-pans, which are cast without handles, pure iron of native manufacture alone is used. The moulds in which the pans are cast require weeks of tedious and patient labor to bring them to perfection. They are composed of two parts, an upper and a lower, and are made of carefully puddled clay. The great secret of the process which enables the Chinese founders to cast their iron pans of such large diameter, yet so thin and light as to be scarcely thicker than a sheet of paper, appears to be the use of highly heated moulds and pure charcoal pig-iron. When the ovens and their contents have cooled down, which takes about two days, the luting attaching the upper portion of the mould to the lower is carefully removed, and, the moulds being separate, the pan can be extracted. When the operation is successful, the same mould can be used several times. The pans now have each attached to its bottom a lump of iron, which, from the extreme brittleness of the pans, requires the greatest care in its removal. These runners are carefully sawn off, and the edges smoothed down; the pan is then ready for the export market. Handles are attached to these pans by the retail dealers.

The pans made at Fatshan differ from the preceding in being cast with handles attached near the rim to the inner surface of the pan, which necessitates the breaking of the mould at each casting. They are usually cast much thicker and heavier than those of Sam-tiu-chuk, and occasionally one-third of foreign pig-iron is mixed with the native iron for casting. In other respects the process followed at both places is the same,

The Old Roman Water Supply.

The excellence of the water system and its minute comprehensiveness of detail is attested not only by the actual surviving aqueducts or their remains, but by the elaborate treatise of Frontinus, the chief ancient authority, whose report on the subject continued to be the service directory for the water system of Rome until the majority of the channels went to decay. He was *curator aquarum* to Nerva and Trajan, and is believed to have died 107 A. D. The aqueduct service included a staff of 700 men, not only to supervise the distribution, but to cleanse and repair the conduits, cisterns, etc., when needed. The nine "ancient" aqueducts included in this report, to which seven of later date were added, cover about three and a half centuries in their period of construction, from 312 B. C., the date of the Appia, to 33 A. D., that of the Claudia and the Anio Novus. The last was a diversion of the Anio bodily by clever engineering into Rome. On the contrary, the bed of the small and shallow Almo, which dried up in summer, became merely a canal for the aqueducts of later date, the Aqua Crabra and Marrana. To Rome the Anio, not the Tiber, was the "Father of Waters," for all purposes save the discharge of impurities. Through the conduits of nearly all these aqueducts, turned upon her like the hose of so many fire engines, Rome drank, bathed, and swam in the Anio. Its main volume, as well as its adjacent and tributary springs, drawn from where the Lower Appennines approach most closely to the great Latin plain, flushed the Appia, Anio, Vetus and Novus, Marcia, Claudia and Hadriana, as of course also the Marcia Pia and the Aqua Felice, the modern representatives of two of the former. The source of the Anio proper is in the summit of the Monte Cantaro, about 63 miles from Rome, and some 2,200 feet above its level. The spring, almost perennially snow-fed, never fails in the hottest and driest weather, and is always cool. As regards purity, the Marcia was highest in esteem, and next to it the Claudia. The Anio and Novus had the largest supply, being the river's residuary volume after being tapped by some other aqueducts.—*The Edinburgh Review.*

The Theory and Calculation of Earthwork Slopes.*

Written for ENGINEERING NEWS.

BY MANSFIELD MERRIMAN, M. AM. SOC. C. E.

Prof. of Civil Engineering at Lehigh University.

Continued from Page 253.

11. SLOPE FOR A GIVEN HEIGHT.—When h is given and ϕ is required the formula for stability may be written in the form

$$\frac{1-\cos(\phi-\varphi)}{\sin\phi}=\frac{H(1-\sin\varphi)}{nh}=b$$

The second member is here a known quantity and may be called b. By developing the numerator in the first member and then substituting for $\sin\phi$ and $\cos\phi$ their values in terms of $\tan\frac{1}{2}\phi$ a quadratic expression results whose solution gives

$$\tan\tfrac{1}{2}\phi=\frac{b+\sin\varphi}{1+\cos\varphi}+\sqrt{-\tan^2\tfrac{1}{2}\varphi+\left(\frac{b+\sin\varphi}{1+\cos\varphi}\right)^2} \quad (18)$$

This determines the slope ϕ for a factor of security n.

For example let it be required to find the slope ϕ for a bank 25 feet high with a factor of security of 1.5, the value of φ being 30° and that of H being 6 feet. Here we have

$$b=\frac{5\times 0.5}{1.5\times 25}=0.0667$$

and then from the formula

$$\tan\tfrac{1}{2}\phi=0.304+\sqrt{-0.0718+0.0922}=0.447$$

Hence $\frac{1}{2}\phi$ is about 24° and ϕ is about 48° or a slope of 0.9 to 1. The slope when built must of course be protected from the action of the weather in order to preserve the cohesion of the earth.

12. FACTOR OF SECURITY OF A SLOPE.—The security of a bank may be investigated by measuring its height h and slope ϕ, and finding by experiment the angle of repose φ and vertical rupturing depth H. Then from (16) we have

$$n=\frac{H(1-\sin\varphi)\sin\phi}{h(1-\cos(\phi-\varphi))} \quad (19)$$

For example let it be required to find the factor n when $h=30$ feet, $\phi=45°$, $\varphi=34°$ and $H=3$ feet. From (19) we find

$$n=\frac{3\times 0.441\times 0.707}{30\times 0.0184}=1.7$$

If such a slope had existed many years and if the values of φ and H were the most unfavorable that could occur, it might be concluded that the factor of security deduced is sufficiently high, but if such a slope should be observed to fail it would be necessary to conclude that the factor is too low.

Formula (19) therefore furnishes the means of determining what the proper values of n should be, and a definite knowledge in regard to it could probably be deduced by measurements and observations taken on fifty or a hundred slopes, some of which have long existed and others of which have failed by sliding.

13. A LOADED BANK.—Sometimes a weight rests upon the natural surface of the ground with a slope below it and evidently the tendency to failure is thereby increased. Let d represent the vertical depth of the uniformly distributed load, as in Fig. 4, and d' the depth of a mass of earth equivalent in weight to the actual load. This weight is distributed as a pressure in the earth and increases the forces P and N proportionally, so that the position of the weakest plane remains unchanged. The general equations (11) and (16) then approximately apply to the case if $h+d'$ be substituted instead of h.

For example let it be required to find the depth d of a layer of stone which will cause

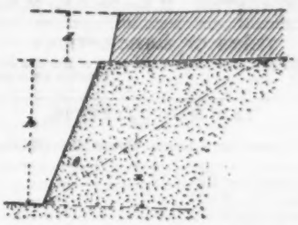


FIG. 4.

the rupture of a bank whose slope is 50° and height 30 feet, the angle of repose of the earth being 34° and the vertical rupturing depth 4 feet. As stone is about 1½ times the density of earth, $d=1\frac{1}{2}d$. Then from formula (11) or (12) we have

$$30\times 1\tfrac{1}{2}d=4\,\frac{0.766\,(1-0.56)}{1-0.96}$$

and from this the value of d is found to be about 2.5 feet.

It is evident that any load placed between the top of the bank and the point M, where the line of rupture cuts the surface, increases the liability to failure, and that a load beyond this point can have little or no effect on the stability.

(TO BE CONTINUED)

Concrete Construction.

ROBERT ABRAHAM.

The result of the experiments made during the progress of the works (at the Westminster Bridewell) was fully confirmatory of the views originally detailed in contract, which required an admixture of 1 part lime to 8 gravel, containing sand in the proportion of ⅓ of the aggregate, or, in other words, ⅛ lime, ⅓ sand, ⅝ gravel. Care and regularity in the execution of the work are of great importance, success very much depending upon the degree of precision and uniformity preserved in proportioning the components. It is, therefore, necessary that such a system be adopted of depositing the material on delivery, either in rectangular or other shaped heaps of uniform size, as will render obvious any deficiency of lime or sand, and be an invariable measure for the requisite quantity of water. The mode of throwing in the concrete is also important, very great advantage being obtained from the rapid consolidation arising from pressure when cast from a height, instead of being laid in steps or layers. The degree of expansion peculiar to concrete when thus executed may be noticed; this takes place immediately the operation of slacking has occurred, giving an urgent reason for the prompt use of the material after mixing, and showing the necessity of using the lime in a perfectly fresh and pure state; large landings are raised very perceptibly by this peculiarity, and the crown of a brick arch has been known to fracture from its effect. It must, however, be stated that this expansion occurs subsequently to an original loss of some magnitude upon the measure of unmixed material, 27 cubic feet of gravel (with its due proportion of sand included), together with 3 feet of ground lime and a little more than 4 cubic feet of water, yielding only 24 feet of concrete.

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Engineering News

AND

AMERICAN CONTRACT JOURNAL.

Tribune Building, - - - New York City.

THE ENGINEERING NEWS PUBLISHING CO. PROPRIETOR.

PUBLISHED EVERY SATURDAY.

CONDUCTED BY

GEO. H. FROST, - - - Assoc. Am. Soc. C. E.
D. McN. STAUFFER M.Am.Soc.C.E.: M.Inst.C.E.

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THE total collapse of eight large buildings on 62nd. Street, this week, demands a close scrutiny into the administration of the building laws of this city. The laws in themselves are defective enough, but bad as they are, if anything like an honest inspection had taken place the present disaster would have been impossible.

Inspection ot the wreck and an investigation into the methods of the builder show that mud was used as mortar to lay poor brick; that the brickwork was run up during the coldest portion of our late winter; that floor beams in many cases rested barely an inch upon these weak walls, and that everything that avarice and a reckless disregard for human life could suggest was done by this criminal builder to save a penny.

Someone should be held responsible for the death-traps run up in this manner; and both the contractors who do the work and the sworn officials who permit it to be done, should be punished as this crime against humanity and good government demands. With the officials rests the chief responsibility, and the present sacrifice of human life and outrage upon honest construction can be charged only to their flagrant dishonesty or gross incompetence.

ENGLISH railways seem at last to be earnestly considering the advisability of adopting the American system of checking baggage. The London and North Western and the Midland railways already announced that they will hereafter check baggage from New York to London if required. This is verily a new departure for conservative John Bull; and, for the peace of mind of the British and American travelling public, we trust the advance made by the above named roads will be followed by other corporations, and extended so as to include the perfect system long in use in this country.

A. R. SWEET, City Engineer of Pawtucket, R. I., in his late report to the Committee on Sewers of that town, has given much useful and interesting detail relating to town drainage.

The Century magazine will, after May 1st, be issued on the first day of each month of date given, instead of the middle of the month preceding nominal date of issue, as heretofore. This change is made necessary by the large editions of each month now demanded, that for May coming being 250,000 copies.

Science, for April 10th, contains an article by Gen. C. P. Stone on "the route from Suakim to Berber." In the same issue Major H. G. Prout contributes "An Estimate of General Gordon's Scientific Characteristics," illustrated by a sketch map of the route from Suakim to Khartoum, a facsimile of one made by General Gordon himself. Major Prout characterizes General Gordon as a highly educated, disciplined military officer, and a wide awake and practical leader of men; he was a man who to a laborious study of the problem in hand brought the aid of a keen intelligence, prompt and accurate judgement and an indomitable will. He was not a man living in a state of mystical exaltation, as popularly supposed, and his great success in various fields of labor was due, not to a "blind and magnificent faith," but to his own patient courage, far-seeing intelligence and unselfish aims.

THE Boston *Daily Globe*, in discussing the question of a successor to the late City Engineer, Mr. Wightman, intimates that there is difficulty in obtaining any one man who can equally well perform the multitudinous duties of the office. It points out that Mr. Wightman literally grew up in the office, and though his duties were constantly being extended he was in a position to grasp all their details. The gathering up of the many points of important works now under construction would not be an easy task for a new man, and the question is being discussed of placing some of these works in the hands of engineers especially detailed.

With all due respect to Mr. Wightman's able administration, we can not help asking the question, who is to be best served by this division of labor, his successor or parties unknown?

Second and Final Report of the Royal Commission on the Metropolitan Sewage Discharge of London.

The above report is without doubt the ablest document on this important subject which has yet appeared, containing as it does the result of the combined investigation and study of the most prominent living engineers of England. As the subject of sewage disposal is a problem daily assuming more awkward proportions in our own country, we make such abstracts from its pages as space permits.

Passing over for the present the supplementary remarks on the evils of the present system and an interesting chronological sketch of the past practice and remedies suggested since the creation of the Metropolitan Board of Works in 1856, we will note the proceedings of the present commission. The Royal Commission was appointed in 1882 to enquire into and report upon the system under which the sewage is discharged into the Thames by the Metropolitan Board of Works; whether any evil results from such discharge, and to devise measures for remedying the same. They had power to call before them all persons likely to afford any information, and in any other manner gather material of value to the subject to be investigated. The Commission has held 81 meetings, and among the Civil Engineers who testified before it were:—Sir Joseph Bazalgette, Sir Robert Rawlinson, Baldwin Latham, Jas. Mansergh, J. C. Melliss, Ed. Pritchart, J. Bailey-Denton, etc.; among the chemists were:—Dr. Aug. Voelcker, Prof. Frankland, Sir Fred. Abel, etc.

The Commission, in acknowledging its indebtedness to these gentlemen, "the best living authorities," and after the comparison of these opinions with a great mass of documentary evidence, express their regret at the obscurity in which, after so many years of study, discussion and experience, the subject of the treatment of sewage appears still to be involved.

In first considering the separation of sewage from rainfall, the one great difficulty met with is the excessive and irregular dilution with water. In 1854 a "separate system" was proposed for London, but the necessary remodelling of the whole of the house drainage, lack of fall in the sewers, and the opinion of the Government Referees, in 1857, that the general surface drainage was little better than house sewage, rendered the scheme absortive, and compelled the designers of the London main drainage to undertake the removal of the sewage and rainfall combined in one system. The mean dry weather flow of sewage proper, as determined by the water supply, is roughly taken at 150,000,000 gallons daily; but this quantity is tripled when the outfall sewers are running full under the pressure of heavy rain. Sir Robert Rawlinson said, in his testimony, that if the problem was to sewer London *de novo* the Fleet Ditch, Ranelagh River and all the valley lines would not now be sewers; they would have been used for surface channels only, and the sewage would have been intercepted on either side. But though a middle course might then have been adopted, the Commission say it is useless to speculate upon this now. But they recommend separation as much as possible in all future extensions of the drainage, as concentration and uniformity are both desirable, either in a chemical treatment or for use on land.

As to the prospect of profit from the utilization of sewage, the Commission do not doubt on general principles the value of the elements in house sewage for fertilizing land. Competent authorities state that 100 tons of average London sewage have a manurial value of 17s. 7d., or a little more than 2d. per ton. Allowing 30 gallons per diem to the individual, or 50 tons per annum, the sewage from a population of 4,000,000 people would be worth at this rate £1,750,000 per annum. In regard to the Edinburgh sewage farming, so often referred to as a successful application of sewage as a land fertilizer, later and more careful investigation considerably modify these opinions, by showing that while the sewage is poured over the land in enormous quantities, the annual produce does not yield more than ¼d. per ton over the cost of application. Sir Robert Rawlinson says the valley of the Thames is not adapted to sewage farming, and puts the value of sewage at ¼d. per ton. Sir John Lawes, Dr's Voelcker and Tidy, Baldwin Latham and Sir F. Abel all substantially agree that it will not pay; that the valuable constituents of sewage are like gold in the sands of the Rhine, enormous in aggregate value, but impossible to gather with profit. B. S. Brundell, C. E., of the Doncaster Sewage Farm, testified that the outside value of 1,134,339 tons of sewage, utilized as best the company could, was only £300 per year, or a net value of about $\frac{1}{16}$d. per ton, or on a farm of 300 acres, of £1 per acre. And in this estimate is not included the interest on the money or cost of pumping, which is done by another company at a cost of £300 per year; the value of the sewage is thus just about the cost of pumping.

While chemical precipitation is easily accomplished, chemical research showed that the idea of the great value of the solids was altogether erroneous. Out of the 17s. per 100 tons, the theoretical value of town sewage, it

was found that only about 2s. lay in the suspended matter, the other 15s. belonged to the matter in solution, The enquiry narrows to the question whether the precipitate has any value whatever, or whether it is to be considered a worthless product to be got rid of in the easiest way possible. In sifting the evidence, the Commission believes that if any profit is to be derived from the utilization of sewage it is by irrigation; but in the present state of knowledge of the subject, there is little hope of any town doing so with the full attainment of the important object, the purification of the sewage. They think there is still less hope of profit from the depositing or precipitating processes; in the improvement of the London drainage they believe that the freeing of the Thames from pollution is a work to be done and paid for whatever the cost may be.

The various plans for the treatment of the Metropolitan sewage are disposed of in the following order:—Broad Irrigation, Filtration through land, Chemical treatment, Precipitation and land treatment combined, removal of outfalls lower down the river and their removal to the sea.

Under the heading of "Broad Irrigation," Sir R. Rawlinson estimates that at 100 persons to the acre London would require 36,500 acres for this purpose without producing disease. Mr. Brundell thought more than one acre would be required for 100 persons, and Col. Hope puts the average at from 50,000 to 100,000 acres, with 30 or 40 persons to the acre. The Commission in digesting the evidence, thinks there is no doubt as to the efficient purification of the sewage by this method with proper care and management, but there is always a danger of failure in management. It must be remembered that in this system the sewage does not, to any large extent, *filter through* the land, but it runs over it, and as at times the farmer may not actually need the sewage, it is easy to turn it directly into the effluent channels and thus evade the purifying process. As regards damage to health, the remarkable power the earth possesses of deodorizing and destroying the noxious properties of sewage in contact with it does away in fact with this objection. Another objection, the adherence of floculent matter to the plants growing in the sewage and the possible introduction of noxious substances into food, is not so easily disposed of. One remedy suggested is the ridging of the ground and the growing of the crops on the ridges, but this adds to the expense and limits the varieties of the crops. A better remedy is the previous separation of the solid particles. Nuisance to the neighborhood is another objection to the sewage farm; the bad odors are not extinguised by the contact with the soil, though it does much to diminish them. The possible pollution of subsoil water is brought as another objection. If the ground is porous, the sewage will percolate into it, and if the sewage is constantly applied the oxidation necessary to its purification may not take place; and though the suspended particles may be arrested the soluble impurities may pass on to the subterranean sources of wells and springs. From a general stand point the Commission find that possible nuisance and pollution of subsoil waters are the chief objections to broad irrigation.

As to cost no estimate can be made with any accuracy. Messrs. Bidder, Hawksley, and Bazalgette estimate that for 3,500,000 population 95,000 acres would be required; and to the cost of the land must be added that of the laying it out and the pumping plant, etc. On the whole the Commission think that while applicable under favorable conditions, broad irrigation will not do for London.

Filtration through Land:—Under this system Dr. Frankland thinks the number of persons per acre can be put at 3,000 or even more; the Rivers Pollution Commission of 1870, on the Mersey and Ribble Basins, estimate this number at 2,000 persons per acre. Bailey-Denton established a system of sewage filtration on the intermittent filtration principle at Merthyr Tydfil. And although at this point the filtering land contains 10 acres used intermittently, and 6 acres irrigated with sewage on the ordinary plan, taking the whole, we have 850 people to the acre, with an effluent good, clear and colorless. The objections advanced to this system are: that it is wasteful, not being fitted for producing crops; the greater nuisance due concentration of sewage; that the soil may be overloaded and clogged, and the great cost of preparing the land. In answer to these objections, Bailey-Denton, with 1,000 persons to the acre, proved at Kendal that remunerative crops can be grown. The clogging of the land and greater nuisance feared have been proven unwarranted by experience; and the cost of preparing the land, under the most difficult circumstances, Bailey-Denton thinks might amount to £150 per acre, and he puts the average cost at £70. The actual cost at Abington was £85.

The Commission sum up on the filtration *through* land as follows: That the process has great scientific merit, and offers valuable practical advantages when broad irrigation is impracticable and suitable land can be obtained. That, however, it appears desirable, that when the area of the land is considerably reduced, the sludge should be removed by some previous, efficient treatment. And that an arrangement of this kind could be applied to the metropolis.

Processes of Deposition or Precipitation:—This includes the treatment of sewage near the present outfalls by deposition or chemical precipitation. As the main object is to purify the effluent, the first point of inquiry is to the extent to which this is done by a chemical process. Sir R. Rawlinson stated that at Leamington the sewage, though apparently clarified at the works, set up a secondry decomposition a mile down the river and became almost as foul as before. Dr. Frankland thought chemical treatment only a temporary measure, that the sewage would increase and the quantity of river water to dilute it would not. The Commission, after hearing much evidence on this head, conclude that the whole art of treating sewage chemically, lies in precipitating and clarifying it while *fresh*, before bacterial invasion has so far advanced as to cause active fermentation. Precipitation consists in producing an artificial coagulum in the fluid which mechanically entangles and carries down the organisms in the sludge. The effluent must then be brought as speedily as possible under an oxydizing influence by turning it into a stream containing sufficient oxygen to accomplish this action, or by applying it to land when similar influences could be brought to bear. If the effluent, however, be kept undiluted, or it be turned into a stream in too large quantities for the free oxygen to deal with, the organisms still remaining in the effluent will multiply and set up a renewed putrifaction.

In considering the treatment of the precipitate remaining, this suspended matter is estimated at about 25 grains per gallon, to which must be added 20 to 25 grains produced by the lime, etc., usually put in; this "sludge," in round numbers, it amounts to about one ton to every 30,000 gallons of sewage, and is of a very foul and offensive nature. Experience has proven that it has little marketable value as a manure, though the "filter press" process reduces the volume to one ton of pressed sludge for about 165,000 gallons of sewage; the cost of this pressing into cakes is given by Mr. Mansergh at about 3s 6*d* per ton of pressed cake. Different witnesses differed widely as to the *quantity* of *sludge* to be dealt with; this item ranged from 600 to 1,100 tons per day for London. With a mean water supply of 150,000,000 gallons daily the Commission estimates the following quantity: wet sludge as deposited, 4,500 tons per day; pressed sludge in cakes, 900 tons per day. This is an enormous quantity, and the natural question is: What will we do with it? It is hopeless to expect ot sell any quantity worth mentioning; but it might be disposed of in raising low land; be burnt; transported away and thrown into the sea, or dug into the land as at Birmingham. On the whole the Commission are of the opinion that though the operation of dealing with the sludge of the metropolis would be of unexampled magnitude, it is not beyond the power of engineering skill, and the cost would not be so excessive as to make the project impracticable. The cost of chemical treatment of the London sewage varies in the estimates, but the Commission conclude that a good and efficient chemical treatment will entail a cost of £200,000 annually.

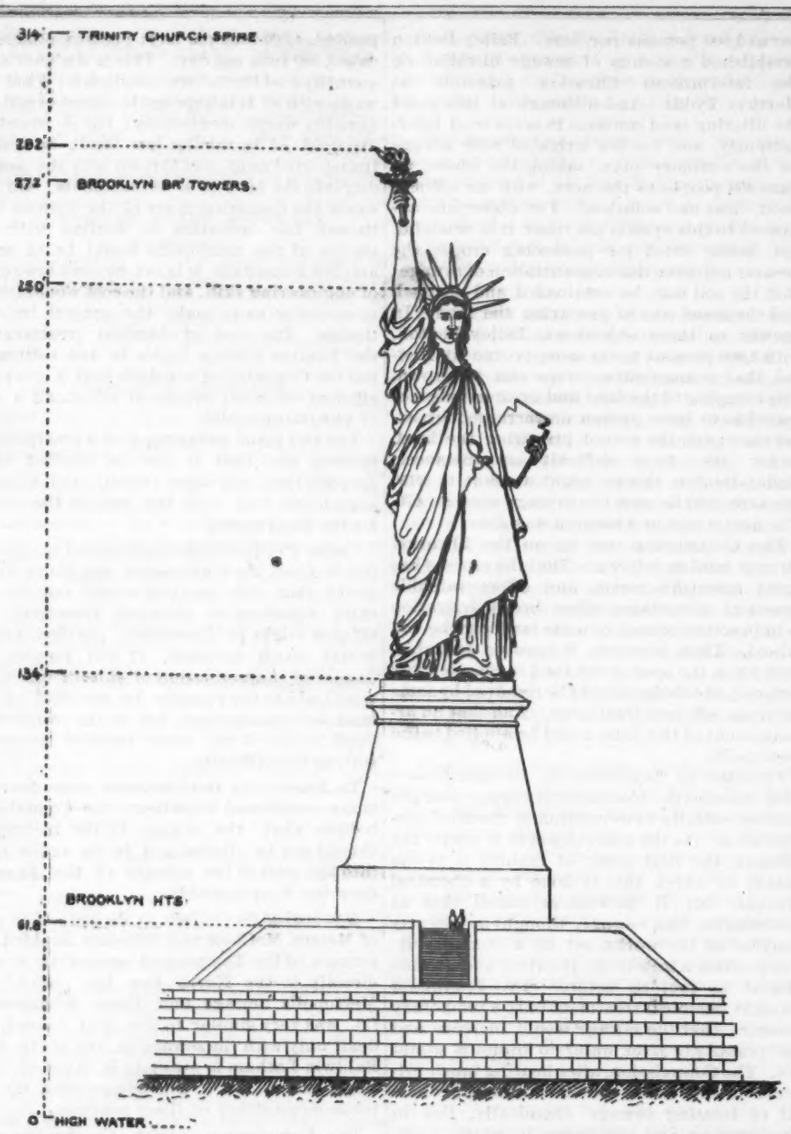
The two great advantages of a precipitation process are: that it can be applied more speedily than any other remedy, and it can be abandoned with only the loss of the outlay for the fixed works.

Under *Precipitation supplemented by Application to Land*, the Commission say there is no doubt that this method would remove the chief objections to chemical treatment; the effluent might be thoroughly purified, and it would much decrease, if not remove the danger of contamination of subsoil water. It would add to the expense by the cost of the land and management, but on the whole they think it one of the most feasible means of solving the difficulty.

To *Remove the Outfalls lower down the river* is not considered expedient: the Commission believe that the sewage of the metropolis should not be discharged in its crude state into any part of the estuary of the Thames, from the Nore upwards.

Removal of the Outfalls to the sea:—The plan of Messrs. McClean and Stileman avoided the estuary of the Thames and carried the sewage directly to the North Sea; the plan of the Metropolis Sewage and Essex Reclamation Co., was very similar to the first named, but dealt only with the sewage on the north side. Baldwin Latham is strongly in favor of "carriage to the sea." The Commission do not recommend either of these schemes.

The Commission, under *Conclusions and Recommendations*, summarizes as follows:—We believe the evils reported imperatively demand a prompt remedy; some process of deposition or precipitation should be used to separate the solid from the liquid portions of the sewage; such process can be conveniently and speedily applied at the two present outfalls; the solid matter, as sludge, can be used in raising low lands, burnt, dug into the land or carried to sea; the remaining liquid portion, as a *preliminary and temporary measure*, can be suffered to escape into the river; its discharge should be rigorously limited to the period between high water and half ebb of each tide, and the top of the discharging orifice should not be less than 6 feet below level of lowest tides. But the Commission believe that the liquid, so separated, would *not* be sufficiently free from noxious matter to allow of its being thus discharged at the present outfalls as a *permanent* measure. It would require further purification; and this, according to the present state of knowledge, can only be done effectually by its application to land. The best method of applying this liquid to land, in the case of the metropolis, is by intermittent filtration. If land can not be secured, suitable and in sufficient quantity, near the southern outfall, the sewage must be carried by conduit under the river to the north side where such land does exist. If suitable land at reasonable cost can not be secured near the present outfalls, they recommend that the liquid sewage be carried down the river at least as far as Hole Haven, and there discharged. In new drainage works the sewage



should, as far as possible, be separted from the rain-fall.

The above report is dated Nov. 27, 1884, and is signed by Baron Bramwell, P. Benson Maxwell, Sir John Coode, C. B. Ewart, A. W. Williamson, F. S. B. F. de Chaumont, Thomas Stevenson and James Abernethy.

The Pedestal for the Statue of Liberty.

The above cut was designed for our last weeks issue, but was unavoidably delayed.

It was intended merely to exhibit to scale, the respective heights of certain points of known altitude on the shores of the harbors near this city, in comparison with the height of the crown of the "Statue of Liberty Enlightening the World," and the torch in her hand, upon the supposition that the pedestal as designed was reduced in height 42 feet, or the foot of the statue, instead of being 176 feet above tide was reduced, as suggested by our contributor, to 134 feet. This latter he claims, while amply high to exhibit the statue to the best possible advantage, will be a saving of at least 50 % in the estimated cost of its completion.

It is not to be supposed that *any one*, with this sketch in hand, together with the full page copy of the official design, shown in our issue of January 7, 1884, could compare the relative effect of the two designs, if carried out as works of art—especially as the scales of the respective designs are so disproportionate. No drawing would fairly represent their relative merits in this respect, while to the ordinary critic, the mere fact of superior dimensions in one of them, would inevitably carry with it the impress of increasde effectiveness.

It is a mistake, however, to infer that, aside from any principle of art involved in the disposition of the leading lines of a composition, that a statue having an extreme elevation of 324 feet, is necessarily more effective than the *same statue* elevated but 282 feet. The latter height may be the limit, beyond which any additional height given to the supporting mass, so far from adding grandeur to the statue, but brings into greater prominence what should be regarded and treated as a wholly subordinate feature.

PERSONAL.

J. M. C. MARBLE, vice president, has been appointed general manager of *the Cincinnati Van Wert & Michigan R. R.*, with headquarters at Van Wert, Ohio.

J. T. HARAHAN having resigned as general superintendent of the Pittsburg division, B. & O. R. R., Mr. J. B. Washington will act as general superintendent until a successor is appointed to Mr. Harahan.

H. R. DILL has been appointed division superintendent of the Kentucky Central R. R., with headquarters at Covington, Ky., in place of Mr. G. W. Bender, resigned. Mr. Dill has heretofore been chief train dispatcher of the Huntington division of the Chesapeake and Ohio.

ROSWELL MILLER is appointed general manager of *the Chicago Milwaukee & St. Paul R. R.*, in place of Mr. S. S. Merrill deceased. Mr. Miller has performed the duties of this office for some two years, with the title of assistant general manager.

D. W. FLICKWIR, C. E., has been appointed chief superintendent and chief engineer of the Shenandoah Valley R. R in place of J. H. Sands and W. W. Coe, resigned, though the latter gentlemen still retain their old positions on the Norfolk & Western R. R.

W. H. COOPER, of the firm of Cooper & Sands, engineers, metallurgists and chemists, is about to develope and report upon the Smart and Fulwood property in Union Co., N. C. The ore on the property is a quartz carrying gold and galena with pyrities.

F. C. PRINDLE, Civil Engineer, U. S. Navy, was detached from the New York Navy Yard on April 9, and placed on waiting orders. The order has no significance. The Secretary of the Navy considered that the strained relations between Mr. Prindle and Commodore Chandler necessitated the detachment of the former.

DAY K. SMITH, having resigned his position as Superintendent of the South Park division of the Union Pacific on account of ill health, was presented by a number of friends along the line with a purse containing $400 in gold. The presentation was made at Como, Col., and was accompanied by a very flattering testimonial of esteem.

CAPT. WM. H. BIXBY, U. S. Eng's is thus complimented by Edward Collignon, Ingenieur en chef des Ponts et Chaussees, in the preface to his new work on *Rèsistance des Materiaux*, "This, our third edition of our text book, owes much to notes made upon the preceeding edition by various engineers, especially by Mr. Bixby, U. S. Engineers, and Mr. Barois; we beg them to accept our thanks therefor."

J. B. CABLE, Superintendent of the Rocky Mountain division of the Northern Pacific has resigned. The resignation takes effect Wednesday, the 15th inst. Mr. Cable was appointed to his present position Jan. 1, 1884, previous to which time he was assistant superintendent of the Fergus Falls division of the Manitoba.

He resigns to accept a position with one of the roads running east from St. Paul. F. W. Gilbert will succeed Mr. Cable. He was some years ago an engineer on the Erie, and came to St. Paul under Chief Engineer Anderson of the Northern Pacific. He built the Brainerd shops, and then went over to Portland as engineer for the Northern Pacific Terminal Company. He is now general manager of that company.

THE list of names published last week as "elected" to the Am. Soc. C. E. on April 1, was the list of names *proposed* for membership. The following is a list of the men *elected* on April 1st:

FOR MEMBERS: Andrew Bryson, Chief Engineer, Hartford and Harlem R. R., and East River and Connecticut R. R. New Haven, Conn; Mathew Joseph Butler, Chief Engineer, Napanee, Tamworth and Quebec Ry., Napanee, Ontario, Canada; Edwin Peleg Dawley, Engineer, New York, Providence and Boston R. R., Providence, R. I.: William Durfee Gellette, Chief Assistant Engineer Central Pacific R. R., San Francisco, Cal; Heliodore John Hilbert, Civil Engineer, Milwaukee, Wis: Louis Robert Walton, Engineer for the St. Bernard Coal Co., Earlington, Ky.: Frank Wallace Whitlock, (elected Junior, October 4th, 1876) Assistant Engineer, City Engineer's Office, Waterbury, Con.

ENGINEERING NEWS three months for One Dollar.

Engineers' Club of Philadelphia.

RECORD OF REGULAR MEETING, APRIL 4TH, 1885.

President J. J. de Kinder in the chair, 46 members and 4 visitors present.

The Secretary presented, for Mr. Jacob H. Yocum, an illustrated description of the recently constructed Water-works at Columbus, Ga., which city has a population of 25,000.

The discussion of Strengthening the West Main Abutment of the Chestnut Street Bridge was continued.

Mr. C. G. Darrach said:—"In Mr. Titlow's criticism of my discussion of the failures and repairs to the Chestnut St. Bridge of February 7th, he says with regard to the crack in the south retaining wall of the western approach (33 feet 9 inches west of the face of the west abutment): 'The opening above the surface of the ground is not a crack, being only a joint of masonry out of which have fallen the small stones and mortar * * * not showing below the surface of the ground for two feet as far as examined.'

I would respectfully submit, that a straight joint does exist in the masonry at this place, but it is not probable that it was originally built five inches wide near the surface of the ground and with a close joint at the top of the wall under the coping. An engineer would not have allowed, nor would a mason have built, such a joint. An examination of this opening shows the cast of the stones (which are now in the wall) in the mortar on the opposite sides of the crack.

Since hearing Mr. Titlow's paper I have made the following measurements and observations:

MEASUREMENTS OF WESTERN APPROACH OF CHESTNUT STREET BRIDGE.

Measured On	— 53 ft. Brick arch.	— Pier.	— 60 ft. Brick arch.	— West abutment.	Pier of iron span.
On north face of approach.					
A—West abutment	× 52 ft. 6⅝ ins.	× 8 ft.	× 59 ft. 11½ ins. ×	"	"
B— "	× 52 ft. 5¾ ins.	× 8 ft.	× 59 ft. 10¾ ins. ×	"	"
Through middle of approach.					
A— "	× 53 ft. 0¼ ins.	× 8 ft.	× 59 ft. 11¾ ins. ×	"	"
B— "	× 52 ft. 10¾ ins.	× 8 ft.	× 59 ft. 11 ins. ×	"	"
On south face of approach.					
A— "	× 52 ft. 7¾ ins.	× 8 ft.	× 60 ft. 0 ins. ×	"	"
B— "	× 52 ft. 6¾ ins.	× 8 ft.	× 59 ft. 11¼ ins. ×	"	"

NOTE—Measurement on the lines A are taken on a level of the bed of the skewbacks. Measurements on the lines B are taken on the level of the top of the water table, which is 6 ft. 8 in. below the bed of the skewback. In this height, viz., 6 ft, 8 ins., the *west abutment pier*, of the iron river span, leans one-eighth of an inch to the west, but seems to be plumb above that point. It is cracked in and above the beveled courses of the buttresses at the northwest and southwest corners.

The *pier* between the two brick arches is badly cracked through in several places and leans ¼ of an inch to the WEST in the 6 feet 8 inches between the water table and the skewback, and 3⅜ inches in its total height of about 29 feet at the coping.

The western abutment of the 53 foot brick arch leans out at the bottom (in the 6 feet 8 inches) to the east as follows: at the north end, 1⅛ inches; in the middle 2⅜ inches, and at the south end 2 inches. This abutment is curved out at the ends to the east and a line stretched between its extremities show the ends to be 2 inches lower than the center at the springing line.

The voussoirs at each end over the skewbacks are cracked in the soffit of the arch. The face of the abutment is cracked in several places, and its length measured at the springing line is 42 feet 9½ inches, or 2½ inches longer than the pier between the two brick arches. The largest crack is 4 feet 5 inches north of the middle of the abutment, and is 1½ inches wide at the springing line, and one inch wide at the water table.

The isometrical sketch made from these measurements seems to indicate: That *the abutment pier* of the iron river span has moved to the WEST 1½ inches at its north and, 1 inch at the middle, and three-fourths of an inch at its south end.

The *pier* between the two brick arches seems to have retained its original position at the level of the water table, but to have been pushed to the west about seven-eighths of an inch at the level of the skewbacks, and 3⅜ inches at the coping, on the level of the roadway.

The western abutment has moved both horizontally and vertically, its ends sinking, the length increasing and the line of top of water table moving in a curved line to the *east* as follows: at the north end 6½ inches, at the middle 1⅜ inches, at the south end 5½ inches.

That the line of the face of skewback has moved *east* at the ends of the abutment and to the WEST in the middle as follows: at the north end 4½ inches *east*; at the middle 0⅜ inches WEST, and at the south end 3½ inches east. The distance between the stone in the south face of the retaining wall at the cracks (33 feet 9 inches west) at this level, and its imprint in the mortar opposite measures 2 inches.

The 53 feet brick arch is distorted and its crown raised; the 60 feet brick arch is also distorted and its crown raised, but not so much as the 53 feet arch.

I think these measurements will confirm my remarks made Febuary 7th, and published in the Proceedings of March 7th.

As I understand Mr. Titlow's paper his contention is that the *center* of the western abutment has been pushed back at the springing line *five* inches to the *west*.

From the observations noted such a movement would have required the small pier and the abutment pier to have moved at least 6 inches to the west, for the 60 feet brick span has been shortened 1 inch and the 53 feet brick span about 5 inches."

Mr. Rudolph Hering said in discussing Mr. Titlow's paper on the Strengthening of Chestnut Street Bridge, that the views contained therein regarding the cause of failure of the bridge, which he further amplified in his subsequent discussion, were untenable on both mathematical and physical grounds, and supported his opinion by blackboard illustration and a model, kindly prepared by Mr. C. E. Taylor, C. E. He said that the existing cracks, bulges, distortions, chipping of coping, change in position of curbs and other signs of motion in the bridge, while they could not be accounted for on the above grounds by a movement of the pier recently strengthened, they could however readily be accounted for on the grounds mentioned by the speaker at the previous meeting, and mainly by the earth-pressure in the approach.

He thus concurred in the views advanced by Prof. Haupt, Mr. Darrach, Mr. Lindsay, Mr. Haslett and others. Finally Mr. Hering said that while he thought this explanation of the failing of the bridge, in opposition to the one advanced by Mr. Titlow, incontrovertible, he considered that a difference of opinion may properly be held as to whether or not the recent work was necessary simply *as a first step* towards remedying the real defects as yet untouched; namely, by giving the abutment pier additional security while the brick arches and west abutment are being repaired, or, whether, as the speaker was inclined to believe, the horizontal struts placed several years ago under the arches, and extending from the west abutment to the abutment pier, might have sufficed during such repairs to resist any dangerous horizontal thrust from the latter.

Prof. L. M. Haupt submitted some photographs of the two western masonry arches and the buttress on the south side of the retaining wall, to show that these portions of the approach do not conform with the neat lines of the segmental arches, as originally designed. The points of sight for the camera were taken in the vertical planes through the axis of the arches to eliminate any distortion due the lens. The views showed a measureable depression of the spandrels on the up grade, and a corresponding elevation on the down grade side. It was his intention to have measured this distortion upon a screen, but an opportunity had not been offered.

Various questions also were asked, and remarks made, by many of the members present.

The Secretary announced the death of the venerable Col. James Worrall, Member of the Club.

HOWARD MURPHY,
Secretary and Treasurer.

Water Supply in the Soudan.

The following communication is taken from our esteemed contempory *The Sanitary Engineer*. The present importance of the subject and the careful observation and opportunities for study of the writer make it especially valuable.

In *The Sanitary Engineer* of March 26 there appeared under the title, "Water-Supply in the Soudan," a letter from Col. Julius W. Adams, asking if there is any ground-water in this country, and if wells can be opened at *any cost*. The Soudan is a big country. Its conditions of climate and topography are far less varied than those of any civilized land of equal area, but still no one man can speak for the whole vast territory known as the Egyptian Soudan.

My own land marches in the dry area of the Soudan covered about 3,000 miles, and officers acting under my orders furnished me itineraries of about 1,000 miles more. I ought to be able to furnish a text for further conjectures on the water-supply.

The rainless area may be said to lie to the north of latitude 17° 30′, roughly speaking, although, of course, the northern limit of periodical rains is advanced in the mountains skirting the Red Sea. In latitude 19° north more or less rain falls in these mountains, and showers are known still further north. West of the mountains, 17° 30′ may be taken as the extreme northern limit of tropical rains. The operations of the English on the Nile have barely penetrated this zone. They are now considerably to the north of it. South of this line rain falls from June to September, increasing in amount as we go south. At El Obeid, in latitude 13° 10′, the total rainfall in 1875 was less than thirteen inches. El Obeid is the capital of Kordofan, very much the largest town of that province, the center of a considerable settled population, and has itself some 10,000 people. The Mudir called it 30,000. It is safe to suppose that it is as well favored with rain as any part of the sorrounding steppes. On the southern border of Kordofan are small groups of mountains, Dar Tagalla and Dar Nouba, about latitude 12° north; and south of these mountains the grassy steppes stretch to the swamp region of the White Nile and Bahrrel Ghazal. Westward the plains rise slowly toward Dar Four, but the rainfall does not increase.

Ground-water for the rainless country north of Kordofan may come from the precipitation on the surface of that province or from the higher countries south and west, and a study of the conditions in Kordofan may indicate what we are to expect further north. The surface is little broken, and rises slowly going west from the Nile. The altitude is about 1,400 feet to 1,900 feet. The Nile at Khartoum is about 1,400 feet above the sea. There are no mountain ranges—only isolated peaks and small groups. A pretty uniform stratum of granitic detritus overlies a stratum of impervious schist to a thickness of 100 to 150 feet. In an area of about 16,000 square miles I found 800 wells. But few escaped my knowledge. These wells are from 75 to 160 feet deep. Only in a few small basins are they shallower. They are narrow shafts, ordinarily curbed. At least one-fourth of these wells are dry for half the year, and most of them yield but little water excepting toward the end of

the rainy season. They are quickly exhausted and fill slowly. As the season advances, entire villages gather their crops, and move to the vicinity of more permanent and plentiful wells, there to stay till the beginning of another rainy season. These are not nomads, but the settled village people. Water for many villages is carried twenty or thirty miles at certain seasons. I have seen it sold at the bazaar of El Obeid for one dollar the vase of about a gallon and a half.

From all these facts I conclude that the water-supply of Kordofan is from the local rainfall; that the permanent wells are where the largest subterranean basins exist in the impervious stratum, and that there would be little profit in prospecting for wells in neighborhoods now supplied but part of the year. Water is the most precious article in the Soudan, and prospecting for it has gone on for generations. What could be found by deep boring is a matter of conjecture, but the possibilities of ordinary digging are nearly exhausted.

In the southern part of Kordofan the water-supply is much better than in the general area of which I have written above. The great Khour Abou-Hable rises in the mountains of Dar Nouba, and may be traced for 190 miles toward the east, receiving the drainage of the northern slopes of Dar Tagalla. In this Khour water actually flows sometimes, and it forms three small lakes, covering respectively, two four, and six square miles. In these lakes water may generally be found on the surface, and always by digging. Wells sunk in the bed of the water course will usually strike water. This was the line of Hick's march into Kordofan, and it was shortly after leaving one of the lakes that he was overwhelmed by the Mahdi.

On the slopes of the great mountain system lying to the west of the Red Sea there may be a better chance of finding ground-water than in the steppe country, but of that region I have made no study except the reconnaissance of the Suakim-Berber route.

Every man who has explored unknown countries must regret that he was not a specialist in everything, and it is unfortunate that no one has yet gone to the Soudan well equipped to study the water-supply problem.

H. G. PROUT,

Late Colonel of the General Staff of the Egyptian Army.

TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page 236*).

To obviate these difficulties and give stronger connections the "keyed-frog" is designed. The parts of this pattern are held together by clamps, and keys or wedges and as they open a larger field for difference in construction four styles of recognized merit are presented in Fig. 78. The previous objection to bolts is done away with, the keys staying set better than nuts and should they loosen are readily driven tight by a blow of the trackwalker's hammer. Since the points are held up by the yoke one tie should be placed under the dove-tail. The general dimensions given for the plate-frog in Fig. 75 are recommended for all patterns of stiff frogs.

As to relative merits I prefer first the "Plate" then the "Keyed" and lastly the "Bolted" style, which latter I do not deem reliable. Against the first named there are urged loose rivets, extra weight of the plate, necessity of sending the frog to the shop for repairs, and too much rigidity. On the other hand it needs no extra attention, a great advantage on roads with a limited force, even if the rivets loosen they do not affect its safety, and should the frog break each part is secured and held safe until a new one is sent to replace it. The advantage of being able to change any one part is more fancied than real. For generally when the wing rails, which as said before are the first to wear, need replacing the point will be too much worn for new wings. The frog bears evenly on the ties. Keyed frogs are very convenient,

FIG. 78a PENNSYLVANIA STEEL CO'S KEYED FROG.

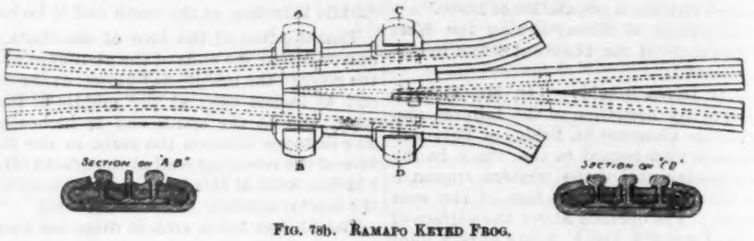


FIG. 78b. RAMAPO KEYED FROG.

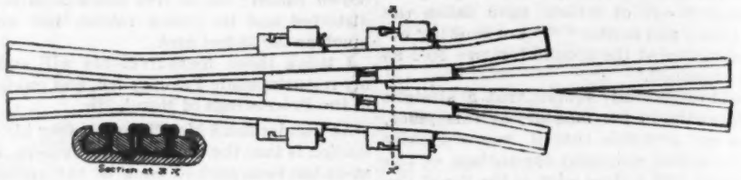


FIG. 78c. BRAHN'S KEYED FROG.

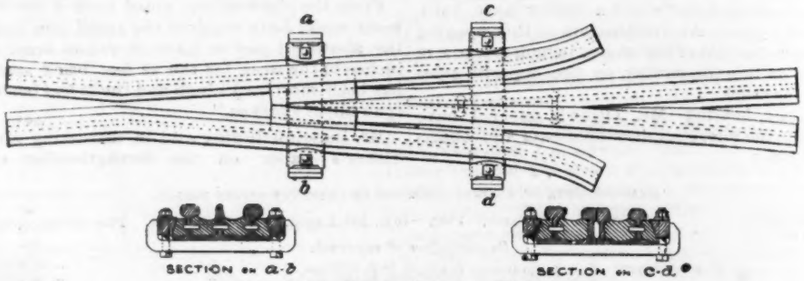


FIG. 78d. STANDARD CLAMPED FROG WITH VERTICAL KEYS.

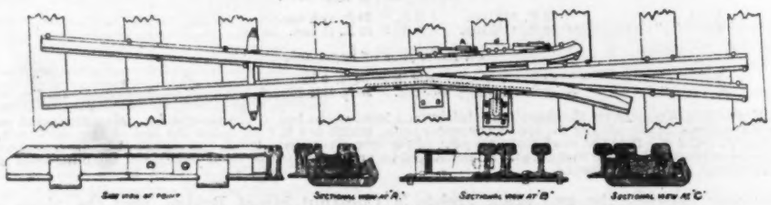


FIG. 79a. PENNSYLVANIA STEEL CO'S KEYED SPRING FROG.

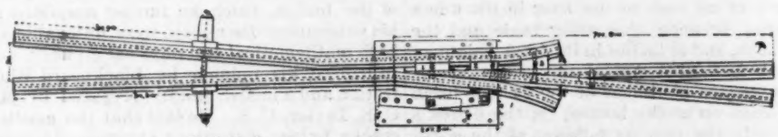


FIG. 79b. PENNSYLVANIA STEEL CO'S PLATE SPRING FROG.

easy to handle, and when in good condition, do not rattle. But they have the objection previously mentioned in connection with bolted frogs, that the side subjected to the greatest traffic cuts down into the ties, especially when they are old, giving the frog a twist, producing great strain on the connections so that they are liable to break or become loose and require more attention. A broken wing rail or tongue is a more serious matter with a Keyed than with a Plate frog. The objections to the bolted pattern have been given.

The trouble with all stiff frogs is the jolt received when riding over them. The wings being worn down, a true wheel must drop into the depression and be suddenly raised by the point, an operation serious on rolling stock and frog. To meet this and always give an unbroken bearing the spring rail frog is devised of which Fig. 79 shows two styles, the Plate and Keyed as manufactured by the Pennsylvania Steel Co.

An examination of this figure shows but one of the wings held fast to the tongue, the other connected to it by a spring contained in the cup-shaped covers shown in the diagram. The movable or spring rail is part of the main track and lying as it does close to the frog point gives the wheels rolling over it an even and unbroken bearing the same as an ordinary rail. When the frog is used on the turnout side with a facing switch the whole flange striking the moveable rail near the throat simply crowds it to one side sufficiently to let them pass through, and when this is done the rail springs back to its normal condition. In precisely the same manner, when approaching from the opposite direction or trailing, the flange meets the curved end of the wing and again forces the spring rail as before. Such a frog is vastly easier on rolling stock than the stiff patterns, and since its life is dependent on the intensity of the pounding, it is consequently more durable both in point of wear and ability to remain in surface. Of the two patterns, Plate or Keyed spring frogs I prefer the Keyed. The reasons

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previously enumerated making the stiff riveted frog superior are not of the same importance when dealing with spring frogs. The jar being removed the parts do not work loose, while the plate now is specially injurious since it catches snow and dirt tending to destroy the ease of movement. I would therefore recommend for all main track work spring rail frogs, and for secondary sidings and yards a Plate stiff frog as being cheaper and capable of repair and construction in the company's own works. Further examination of Fig. 79 shows that the wing of the spring rail in the Keyed frog is longer than the wing of the fixed rail. Formerly both the wings, as shown in the plate frog, were made the same length, but it renders an accident possible to a "*hollow tire*" or "double flanged" wheel trailing through. When the wheel reaches a place where the worn channel is wider than the tongue it drops down, bringing the outside flange lower than the wing. Sometimes it will climb up the rail and go over all right, at others it will force the spring rail entirely out of place and drop off the point. By prolonging the wing the outside of the tread is caught and a given bearing before the operation before described can take place.

(TO BE CONTINUED.)

French Rock Asphalte.

The demand in the United States for French Rock Asphalte work has so largely increased within the past few years that any data concerning this valuable material will be of interest.

Seyssel Rock Asphalte is a limestone impregnated with about ten per cent. of bitumen and is obtained from the quarries at Pyrimont Seyssel Department of the Ain, France. It is a tough, chocolate colored stone of nearly the same specific gravity as a well-burned brick. Though not malleable when cold, it becomes so if sufficiently warmed, while a higher heat (140°), reduces it to powder.

The origin of bitumen, the generic name of several hydrocarbons, but slightly oxygenated, varying in consistency from a fluid to a compact tough solid, with changes in the proportions of the constituent elements, is rather conjectural, it is not yet fully understood. Its elements, carbon, hydrogen and oxygen, indicate its derivation from organic substances buried in the earths' crust through changes effected by decomposition and recondensation under varying conditions of temperature. It is found in the vicinity of extinct and existing volcanic action, and it has, also, in limited districts, permeated sand grits and argillaceous and calcareous rocks of the secondary geological formation. By boiling the sand grits, mineral tar or bitumen can be obtained, which is used to convert the Asphalte Rock into a mastic. The mastic is made into blocks of a size that can be readily handled, and they bear the trade mark of the manufacturers to prevent deception. When wanted for use the blocks are broken and after having been properly heated, about fifty per cent. of fine, clean grit is added, with from five to ten per cent. of bitumen, according to the degree of hardness required of the finished work. It is spread, while hot, in one or two layers, and as soon as it has cooled it is ready for use, presenting a durable, even surface, water-tight and fire-proof.

Being absolutely impervious to moisture it is largely used for sanitary purposes and for stables, laundries, brewery and cellar floors. It is strictly non-combustable, and for that reason admirably suitable for roofs and for floors of buildings required to be fireproof. In this connection it might be observed that all the floors of the new Church Street building of the American Bank Note Company, in New York, are of this Rock Asphalte on which is placed their heavy machinery.

The sidewalks, etc., of Seyssel Rock Asphalte in Paris, are so well known that no allusion is necessary here. In New York a great deal has been already done in this way, notably Union Square and a fine piece of work on the western side of Fifth Avenue from Sixtieth to Eighty-Fifth Street. Other asphaltes have been used there with more or less success, but as a geneaal rule they have not proved to be so durable. M. Léon Malo and other eminent French engineers, have always given the preference to Seyssel, which obtained "for superiority over all other asphaltes" the only gold medal at the Paris Exhibition of 1878. The Compagme Générale des Mines d'Asphalt, owners of these extensive mines since 1794 have their New York Office at 29 Waverley Place.

LITERATURE.

Annual Report of the Chief of Engineers, U. S. A., to the Secretary of War for the year 1884. Washington: Government Printing Office, 1885.

This report consists of four volumes, embracing more than 2,900 pages of information concerning the surveys and improvements in charge of the corps of engineers. It appears this year three or four months earlier than the customary time, which renders it more than usually valuable, and it would seem that its value might be greater still if published in December, since the detailed information that it contains is really necessary for the guidance of Congress in making the appropriations for the following fiscal year. In the remarks we have to make this week the first part or volume will alone be considered.

The very full table of contents, covering nineteen pages, is a new feature of these reports, and will prove of great assistance to all who use them. The customary alphabetical index of localities is also given at the end of each volume. The report of General Newton recapitulating the special reports and estimates, occupies 350 pages, and this consists of two principal divisions, one relating to sea coast and lake frontier defenses, and the other to river and harbor improvements. Here a brief account of the progress of the work at each locality is made and accompanied by a statement of expenditures. The estimate for construction and ornament of the principal harbors as prepared by a board of engineers is $60,000,000, and no doubt is entertained that, with the addition of submarine mines, this would prove sufficient to render them impregnable to naval attack. The number of officers in the corps of engineers at the end of the fiscal year is 101, and a full statement of their rank and duties occupies nineteen pages. The number of civilians employed in the capacity of civil engineers is not stated, and would probably be difficult to estimate, since a large proportion are engaged only for a portion of the year in field work and construction.

The laws passed at the first session of the Forty-eighth Congress affecting the corps of engineers occupy 45 pages, and the appropriations for each locality are given in detail, but no totals are stated. The sum of $125,000 was appropriated as a lump sum for examinations, surveys and contingencies of about 130 enumerated localities. A similar provision had been included in the act of 1882, and of 147 localities examined, 76 were reported as not worthy of improvement. As the last session of congress failed to pass the river and harbor bill, the amount available for the next fiscal year will consist only of unexpended balances from previous appropriations.

The detailed reports of the engineer officers and their assistant engineers begin on page 421, and occupy the remainder of this volume and the three following Of these 38 pages relate to fortifications, and the rest to rivers, harbors and surveys. To mention each of these reports in a brief review would obviously be impractible, but it should be said that while their general character is statistical and official, many contain engineering information of value and interest. The accompanying maps differ considerably in the details of execution, as would naturally be expected when drawn in different offices, but on the whole are more uniform than in the reports of some previous years.

Colonel Blunt makes an extended statement regarding the improvement of Great Bay, about five miles above Portsmouth, N. H. This is an expanse of water covering twelve square miles, which is alternately filled and emptied by the tidal current, and acting like a great reservoir causes a rapid and dangerous current in the harbor of Portsmouth and in the lower part of the Piscataqua river. The proposed method of improvement is to construct a lock and dam across the river just below the mouth of Great Bay, the length of dam being about 835 feet and the depth of water along its site from 12 to 49 feet. The estimated cost of this construction is $710,000.

Major Raymond's report includes an estimate for the construction of a harbor of refuge at Sandy Bay, near Rockport, Mass., by means of a breakwater, whose maximum cost is regarded as $4,000,000. This is accompanied by a mathematical discussion of the proper cross-section of the breakwater, together with an investigation of the anchorage capacity of harbors, in which it is shown that the proposed harbor at Sandy Bay will accommodate about 2.9 ships or 3.2 fishing vessels per acre, and that if necessary 3,000 vessels could conveniently find anchor there. The sum of $100,000 was appropriated to begin this work, subject to the approval of a board of engineers, whose report, we think, has not yet been rendered.

Colonel Elliot's report contains an account of the preliminary examination and survey of Pawtucket river, R. I., where an increased width and depth of channel seem to be required. The estimate for this is $382,000, which includes 148,000 yards of mud excavation at 35 cents, 275,667 yards of gravel and sand at 80 cents, and 5,467 yards of rock at $35.00.

Colonel McFarland reports that the total length of the breakwater completed at the entrance to the harbor of New Haven, Conn., is 1,517 linear feet, containing 161,892 tons of stone, and that its cost has been about $99 per foot. He recommends that a second breakwater be begun in accordance with the plan adopted in 1879. The estimated cost of the improvement was $1,311,134, of which only about $220,000 had been expended at the date of his report.

Captain Mercur's report contains a statement of the expenditures on the Hudson river between Albany and Troy, from which it appears that $1,027,000 has been appropriated since 1864, and that a comparatively small sum will suffice for the permanent completion of the work. The improvement of Harlem river from Randall's Island to the Hudson, for which $400,000 had been appropriated was not begun at the time of his report, as the action of the court concerning the right of way to the United States had not been rendered. The estimate for this important improvement was $2,100,000, and the benefit to commerce will be very great. For Peekskill harbor $137,000 was estimated for dikes and dredging, but no appropriation was made by Congress.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.; M. INST. C. E.

(CONTINUED FROM PAGE 206).

DCCXXXV—COTTAGE CITY, MASS.

Cottage City, Massachusetts, in lat. 41° 23′ N, long. 70° 41′ W, is on the island of Martha's Vineyard.

Water-Works were built in 1884 for the Fire District by Moses Joy, Jr., taking the supply from Lake Anthony. The lake covers an area of 10 acres and is supplied by springs, and at its outlet a dam is built to keep out the tide.

The water is pumped by a Knowles steam fire pump, of 500,000 gallons daily capacity, directly into the mains.

Distribution is by ½ a mile of 10-inch cast-iron pipe with 7 fire-hydrants.

The works are for fire protection only, and have cost $10,000. The population in 1880 was 672.

DCCXXXVI—MCPHERSON, KAN.

McPherson, Kansas, in lat. 38° 25′ N., long 97° 40′ W., the county seat of McPherson Co., is in a fertile district of rolling prairie land.

It is now an incorporated city.

Water-Works were built in 1883 by the city.

The supply is taken from a well of 4-inch diameter, 90 feet deep, yielding 57,000 gallons daily, and is thence lifted by a pump, driven by an Eclipse wind-mill 22 feet in diameter, to a wooden tank holding 80,000 gallons, set on a timber trestle 41 feet high in the center of the city.

Distribution is by 1700 feet of 6-inch wrought-iron pipe with 8 fire hydrants and 6 taps. Service pipes are of wrought-iron. No meters are used. The daily consumption is 750 gallons.

The works have cost $8,000. The bonded debt is $7,000 at 7 per cent. The yearly expenses of maintenance are $100, and the receipts $200.

The population in 1880 was 1,590.

W. H. Nelson, the City Marshall, has charge of the works.

DCCXXXVII—AMESBURY AND SALISBURY, MASS.

The towns of Amesbury and Salisbury, Essex Co., Massachusetts, in lat. 43° N., long 70° 56 W. are in a rough district on Powow River, and have large manufacturing interests.

Water-works were built in 1884, for their joint supply, by a private company after plans of Chas. A Smith, the supply being taken from ground water. From 36 tubular wells 45 ft. deep connected by a horizontal suction pipe 15 feet below the surface, at which depth the pumps are placed, the water is pumped by two Worthington pumps of 1,000,000 gallons daily capacity each, lifting 200 feet to a reservoir constructed in earth excavation, the bottom and inner slopes puddled and paved with boulders, holding 3,000,000 gallons and being 240 feet above the towns.

Distribution is by 6 miles of cast iron-pipe of 12 to 6-inch diameter, with 75 fire hydrants

and 12 gates. The works having just been completed the number of taps is not stated. Service pipes will be of lead. The towns pay $30 annually for the use of each hydrant.

The cost of the works has been $60,000.

The combined population of the towns in 1880 was 7,434.

R. F. Briggs is President, and E. Ripley Sibley Treasurer of the company.

DCCXXXVIII—HOPKINTON, MASS.

Hopkinton, Middlesex Co., Massachusetts, is in lat. 42° 30′ N., long 71° 30′ W.

Water-works were built by the town in 1884, taking the supply from three artesian wells. The wells are respectively 75, 65 and 57 feet deep, 73 feet of the first, 57 of the second, and 37 feet of the third being bored in rock. The water is pumped by a Deane steam-pump to an iron tank 35 feet in height, holding 250,000 gallon and being 142 feet above the lowest part of the town.

Distribution is by 1½ miles of cast-iron pipe with 15 fire hydrants. Service pipes, of which there are none as yet laid, will be of wrought-iron.

The cost of the works has been about $19,000, which is the amount of the bonded debt at 4 per cent.

The population in 1880 was 4,601.

Geo. W. Hunt, is Chairman of the water-works Committee.

WATER.

LIMA, Ohio, has elected Thos. Fitzgerald, Wilbur Fisk and C. A. Mathews as Water-works Trustees.

HAROLD & MCDONALD, contractors, have resumed work on the new government dam No. 6, on the Great Kanawha River, at Charleston, W. Va.

BIDS are wanted for street improvements in Atlanta, Ga., and also for the purchase of the Atlanta water-works.

J. J. NEWMAN, of Providence, R. I., has been awarded the contract for constructing a system of water-works for Gardiner, Maine. It includes a reservoir and about 12 miles of pipe.

COL. CHICHESTER, superintendent of the water company of Duluth, Minn., will use two miles each of water and gas mains for extensions the coming season. This will be in addition to repairs.

BIDS were solicited for 3,135 feet of 12-inch water pipe to be laid on Market street, Nashville, Tenn., from the Square to Jefferson street and 3,950 feet of 8-inch pipe to be laid on Market from Jefferson to Monroe, and on Monroe from Market to McLemore.

MATTOON, ILL., closed a contract on April 10, with Fairbanks, Morse & Co., of Chicago, for the construction of water-works, to cost about $75,000. The city will pay an annual rental of $5,000 for seventy hydrants. The city has just paid off $20,000 of its bonded debt.

NEWARK, N. J., has issued proposals for building and erecting the pumping machinery, boilers and chimney for the Improved Sewerage works of that city. Bids to be in by April 27th. The pumps must lift 15,000,000 gallons per 24 hours, 20 feet high,—the city build the foundations.

AN Atlanta man claims to have discovered a new principle in hydraulics which upsets the old theory that water will not rise in a vacuum more than thirty-three feet. He says that he can pump water any distance required, and partially proves his assertion by pumping it 600 feet without a valve and on a direct vertical rise.

THE committee on the Caker water-works system for Sedalia, Mo., which proposes to establish an underground reservoir for supplying the city with pure soft water from the lower formations, held a meeting on April 7th, at which it was decided to make a proposition to purchase the present water franchise from the city, with the existing water-works, organize a joint stock company and establish the Baker system.

THE supposed impure qualities of the drinking water supplied to Chicago were made the subject of investigation by a special committee of experts, who visited the crib in Lake Michigan through which the water filtrates and reaches the city by means of a tunnel. They found the river water and sewage three miles beyond the crib plainly visible, the crib-keepers estimating that they extend that far and discolored the water, apparently extending down to the bottom of the lake.

THE importance of wholesome potable water for cities is shown at Vienna. Since the introduction into that city of water drawn from the Syrian Alps a constant and very considerable decrease has been observed in stomach and intestinal troubles, and cases of typhus-fever have become rare.

MOBERLY, Mo., voted on March 17th in favor of letting a contract for water-works for that town to Messrs Miner & Martin. The supply will be surface water; reservoir capacity 100,000,000 gallons, covering 28 acres. Contract calls for 5½ miles of pipe, and 70 fire hydrants. The city is to pay $6,000 per annum for water-rental. E. Cook, C. E. is making the necessary surveys for the water supply, and work is to be commenced in May.

PHILADELPHIA Councils are considering the propriety of taking $1,000,000 from the surplus of the Gas Trust and applying it to the completion of two sections of the East Park Reservoir and necessary mains, and for construction on the Cambria Reservoir. Some members object, on behalf of the old Gas Works ring, to this diversion of the savings of the Gas Department.

THE bill before the Pa. Legislature to authorize Philadelphia to borrow $3,000,000 to improve the water supply, passed second reading, without opposition, on April 13th, though the voice of George Robinson rang out a "no" against it. Robinson will oppose the bill on third reading on the ground that the $1,000,000 which the Water Department now receives above its expenses should be applied to improvement, instead of being turned into the general fund of the city. He will also urge that the city will receive $1,800,000 from the Gas Trust in July, and that only two-thirds of the citizens pay water rates, which, as the water rates are now applied, amounts to taxing two-thirds of the citizens for general purposes. Most of the Philadelphia dele gation, however, have expressed themselves as in favor of the loan.—Phila. *Press*.

"AN ENGINEER," writing to the N. Y. *Sun* of April 14th, objects to the proposed Hudson Valley Aqueduct scheme now before the N. Y. Legislature. He claims that the bill as framed will permit the taking of water from the Hudson River below, as well as above Glen's Falls, and also authorizes the taking of water from any or all of the affluents of the Hudson River and the lakes lying in the Hudson valley. The last named clause would interfere with the franchise of the Ramapo Improvement Co. "Engineer" believes that this diversion of the upper waters of the Hudson will seriously impair navigation, and gives figures to support his argument. The granting of this charter would also interfere with the proposition, long ago made, to use these lakes in the upper Hudson as a series of storage reservoirs for the improvement of navigation in the river.

THE Western Waterways Convention organized in New Orleans on April 7th, with Gov. Robert Lowry, of Mississippi, as President. It required some tact to avoid a conflict between the rival friends of Capt. Eads and the River Commission. The former killed off a resolution indorsing Gen. Gilmore and the River Commission, and the latter tabled a long paper from Capt. Eads elaborating his scheme of river improvement. The convention will take a trip to the jetties.

The resolutions of the convention insist that it is the duty of the Government, in the interest of the domestic commerce of half the States of the Union, to cause to be made such improvement by the Western waterways as shall permanently secure easy and safe navigation and prevent the overthrow thereof. The Secretary of War is called on to permit the use of unexpended balances. The action of the Executive Committee on the Improvement of Waterways is approved, and Congress is memorialized to make appropriations for the establishment of free water communication between the valley of the great river of the West and tidewater of the East in accordance with the recommendations made.

THE following is an abstract of the bids for laying the new 20-inch main between Lakes Lawson and Bradford, opened recently by the board of water commissioners of Norfolk, Va.:

For laying alone—Adam Miller & Co., Rome, N. Y. 66 cents per foot; Sykes & Gwathmey, Norfolk, 67c.; John W Rutherford, Hoboken, N. J., 68c.; A. J. Dalton, Norfolk, 75c.; Daniel Maloney, Norfolk, 76c.; Leach & Baldwin, Philadelphia, 78c.; Hutchinson Bros., Baltimore, Md., 83c.; John B. Collins & Co., Norfolk, 86c.; Inman Bros., New York, 90c.; J. A. Donaghue & Co., Baltimore, Md., 95c; W. R. Weaver & Co., Norfolk, $1.05; Virginius Freeman & Co., Norfolk, $1.15; Peed & Neville, Norfolk, $1.50.

Pipe alone—Warren Foundry, Phillipsburg, N. J., $27.90 per ton of 2,240 pounds; Camden Iron Works, Philadelphia, $28; Mellert Foundry, Reading Pa., $28.50; A. H. McNeal, Burlington, N. J., $29; Cincinnati & Newport Company, Newport, Ky., $27.85 per ton of 2,000 pounds; Tredegar Iron Works, Richmond, Va., $26; Peed & Neville, Norfolk, $26 per ton of 1,912 pounds.

Pipe and laying complete—Camden Iron Works, Philadelphia, $36,791.04; Inman Bros., New York, $40,505.32; W. R. Weaver, Norfolk, $44,616; Peed & Neville, Norfolk, $51,215.

The Camden Iron Works received the contract.

J. E. FULLER, C. E., of the Manhattan Construction Co., of New York, has made a proposition to the Councils of Gadsden, Ala., to erect water-works for the sum of $50,000. The supply is to be sufficient for 15,000 people, the city to pay $75 each for fire hydrant-metal and the works to be completed in six months. The proposition has been accepted, says the Chattanooga *Times*, and the works will be built at once.

THE water supply of St. Petersburg is found to contain only 300 germs of the cubic centimetre, although the source from which the supply is obtained contains bacteria to the number of 10,000 per cubic centimetre. Investigation shows that the destruction of the germs is due to the rapid motion of the water where it leaves the main source of supply. Acting upon this discovery, a noted engineer recently employed a centrifugal machine which he constructed hastily, and found that after subjecting the impure water to action for one hour, the number of germs was reduced 90 per cent. Upon the basis of this experiment, it would seem possible to clear a city's water supply by subjecting it to a centrifugal motion.

NEWS OF THE WEEK.

Railroads, Bridges and Canals.

California Southern.—It is the reported intention of the California Southern Railroad to complete its connection with the Atlantic and Pacific by January 1, 1886.

Boston and Albany Railroad.—Officials deny the report of a proposed extention of their road from Westfield, Mass., to Litchfield, Conn.

Tunnels will not be built by the California Southern in the Cajon pass, as at first reported, the substitution of open cuts having been recommended by the engineers.

California & Oregon R. R.—It is reported that Sisson & Crocker are contracting for large numbers of Chinese laborers to complete the construction of the California and Oregon at an early date.

Nebraska Central.—Contracts are said to have been let for grading 100 miles of the proposed Nebraska Central road. This road will, it is said, bridge the Missouri at Decatur.

The St. Paul Elevated Railway.—Gentlemen interested in the proposed elevated railroad state that the action of the committee on streets, in declining to indorse their petition for street privileges in the city, will not put a stop to their efforts to secure the use of the streets for the proposed line.

A Honduras R. R.—A London syndicate has entered into a contract with the government of Honduras to build and operate in that country an inter-oceanic railway. The concession granted the syndicate by Honduras includes land grants and mining privileges.

Central Pacific—The San Francisco *Bulletin* says it is thought that the Central Pacific will soon begin work on the Oregon & California extension. There remain only 150 miles between the terminus in California and that in Oregon.

The North Pacific.—Track-laying has been commenced on the Northern Pacific bridge over the St. Louis Bay, connecting Duluth with West Superior. All the steel and ties necessary to complete the work are at Duluth., and the track-laying will be finished in short order. The bridge will be both for foot passengers and railroad trains.

R. R. Contract Awarded.—The contract for building the Minneapolis, Sault Ste. Marie & Atlantic extension eastward from Bruce, has been awarded to Henry & Balch of Minneapolis. This firm is now erecting a large double truss bridge over the Chippewa river at Bruce, and expect to have a thousand men at work grading the new work by May. 1.

The Maricopa and Phœnix Railroad, which will connect the Southern Pacific with the Atlantic Pacific, has organized with the following officers: President, John J. Valentine; Vice President, Monroe Salisbury; Treasurer, Homer S. King; Secretary, E. B. Young. Among the Directors are Joseph S. Robertson, Hugh White and Austin Carrington.

Work Resumed.—Word was received in St. Paul recently to the effect that work has been resumed on the Northwestern's extension from Valentine, Neb., to the Pine Ridge agency, a distance of 160 miles. P. E. Hall, formerly general manager of the Sioux City & Pacific, is in charge of the work.

The extension of the Pennsylvania Schuylkill Valley Railroad to the anthracite coal regions will be built during the present year. A large number of men are now engaged in grading upon several sections of the railroad between Hamburg and Pottsville. The route from Hamburg will follow along the line of the Reading Railroad as far North as Landingville, where it will diverge and again reach the Schuylkill River at Schuylkill Haven.

The King Iron Bridge and Manufacturing Co., have taken a contract for building an iron deck bridge for the N. Y. L. E. & W. Ry., to be erected across Scranton Avenue in Cleveland, Ohio, on line of the N. Y. P. & O. Ry., leased by the Erie. The bridge will be a riveted truss and completed by May 15th.

The New Reading and Chesapeake Railroad, which is to enter Reading, Pa., on the opposite side of the river, sent out a force of surveyors from that city on April 9, to begin the work of surveying the route. It will probably connect with the lately built Pennsylvania Schuylkill Valley Road somewhere near the mouth of the Wyomissing, which empties into the Schuylkill about 100 feet from where the latter road crosses the river. The Reading and Chesapeake Road is building partly by local and in a considerable degree by New York capital.

Chattanooga & Charleston R. R. Revived.—The Chattanooga *Times* says: A company known as the Chattanooga and Charleston railroad company has been revived, to extend the railroad recently built from Charleston, S. C. to Augusta, Ga., to Chattanooga, to connect with the Memphis and Charleston railroad, in Chattanooga. The company is now advertising for right of way in all the counties it traverses in Georgia. The right of way passes through Dalton and enters Chattanooga by way of McFarland's gap. It is stated that considerable capital has been enlisted in the enterprise.

A New Invention.—Passenger locomotive 23, of the Pittsburg & Lake Erie R. R., in charge of Engineer Geo. Orr, has a patent attachment on the trucks of the tender that is worthy of mention. Heretofore the boxes around the journals have been packed with waste saturated with oil, which admitted of considerable loss of oil, while the wheels were in motion. The new invention consists of two rollers made of compressed paper. The rollers are of the same diameter as those used in roller skates, and in the center of each is a loose chain which hangs in the oil. When the wheel is in motion it strikes the paper wheel, thus revolving the chain and throwing oil constantly against the journal. There is no waste of oil if the boxes are made tight and the amount of oil used is very much less than when waste is packed in.

New Roads Incorporated.—*The Lake Michigan and Ohio River R. R.*; capital stock $100,000; designed to connect Yeddo in Fountain Co. with Jasper in Dubois Co., O.

North Conway and Mt. Kearsage R. R., stock $400,000.

Calumet and Cheltenham Beach Horse Railway of Chicago, Ill. Capital $100,000.

Toledo, Kokoma and St Louis R. R., to run from a point in Adams Co., in Indiana, to the western boundary, a distance of 170 miles.

Cleveland, Toledo and Lakeside R. R.; Capital $150,000; the line to be wholly within Ottawa County, with main office in Sandusky, O. The object is to carry passengers to the Lake in summer.

The Hamilton, Guelph and Buffalo R. R. to run between Hamilton and Galt, Canada. Capital stock $60,000.

Mexican Central R. R.—The following is from the report of the Mexican Central for 1884.

The main line, City of Mexico to El Paso, Tex., was completed and put into operation in April last.

The present mileage is as follows: City of Mexico to El Paso, 1,234.2; Guanajuato Branch, 11.4; branch to Stone Quarry, 6.5; Tampico Division, 96; San Blas Division, 16; total, 1,354.1.

Tampico Division—At the date of the last report the track was at kilometre 156, and will soon reach kilometre 183 east of Tampico, at which point it is hoped that sufficient business will be received to pay operating expenses.

Pacific Division—The Directors are of opinion that it would be more profitable to the company, and better for the people of Mexico, to build from the main line to Guadalajara, than to continue building from San Blas. At present the expenses of this division are very light.

Equipment—The company's equipment, exclusive of road department cars, was on December 31, 1884, as follows: Locomotives, 96; passenger equipment, 89 cars; freight equipment, 1,954 cars.

The Sioux City Bridge.—It is reported that the building of a bridge across the Missouri River at Sioux City is still a question. The Boston capitalists believe that the cost of building the bridge, with levee repairs, is in accordance with what the estimated income from the bridge would justify. It is believed that the Omaha Road wants exclusive use of the bridge when completed, which the bridge company will not willingly accede to. The bill for reviving the franchise of the Sioux City branch of the Union Pacific is not dead yet, and if passed by the Senate, will result in a line from the Missouri west to a connection with the Union Pacific in Wyoming. The Omaha will, by insisting on an exclusive use of the bridge, retard the building of such a line, which would be a most important feeder to the Omaha if built.

The Baltimore & Ohio have at last practically succeeded in obtaining their right of way into Philadelphia. The original plan is to be adhered to and the road will cross the Schuylkill below the Gray's Ferry Bridge, follow the wharves on the East side to about Arch Street, where the river takes a bend to the West, and thence in a direct line to Twenty-third Street and Pennsylvania Avenue, where connection is made with the tracks of the Philadelphia and Reading. Nothing but the adverse action of Councils or two or three property owners can prevent the successful completion of this route.

It must be understood that the Baltimore and Ohio, as a corporation, does not enter over this line. The route in question is to be owned and operated by the Schuylkill River East Side Railway, a company incorporated under the laws of Pennsylvania, and doing business simply in the county of Philadelphia. This line is the connecting link between the Baltimore and Ohio and the Philadelphia and Reading, and it is over its tracks that the two companies propose to exchange business. Although not a foot of track has been laid, the right of way has been almost completely secured, and actual construction may begin at any time.

Another Huge Tunnel.—As one of the terms upon which Prince Edward's Island entered the Dominion, the Canadian Government were to keep up a continuous steam communication between mainland and island winter and summer. This part of the terms of the union the Government have failed to carry out, and the British Government has been appealed to. Senator Howland believes he has solved the difficulty, and on April 8th submitted to the Senate plans and profiles of a scheme by which steam communication may be carried on all year round by a system of tunneling such as now runs under the Clyde, Severn and Thames, and which has been favorably reported upon by Vernon Smith, C. E., well known in engineering circles in America and Great Britain. The total distance from Cape Tormentine to Cape Traverse, the two terminal points, is eight and a half miles. Between these two points are the Straits of Northumberland. Senator Howland proposed to run a tunnel composed of metal cylinders three-eights inches thick, fifteen feet in diameter, lined with concrete two and a half feet thick, giving a clear passage way of ten feet, through which cars may be drawn by fireless engines. Ventilation will be secured from a shaft sunk about half way across the straits, at which point the water is ninety feet deep. The minimum current is about one knot, which even during the heaviest gales does not exceed four knots per hour. The total cost is estimated at $2,000,000.

French Sleeping Cars are now run on all lines out of Paris except to London. The Compagnie International des Wagonslits corresponds to the American Pullman, and through berths can be secured from Paris to Rome, via the Mont Cenis Tunnel, from Calais to Brindisi through the St. Gothard tunnel, from Paris to Frankfort, Strasburg and Vienna, and, before long from Paris via Berlin to St. Petersburg. The sleepers are smaller than Pullman cars. The cabins are all on one side of the car; on the other is an aisle running the entire length of the coach, with wide windows, close to which are fixed stools for the benefit of travelers. The beds are rather narrow, but the mattresses are good, the covering clean and plentiful. Instead of reposing with your feet towards the engine, you travel sideways The cabins are lined with maple and oak, and the doors may be locked on the inside. The roof of your little room is of canvas, painted a sky blue, with birds in red and black flying around among fleecy clouds of gray. The bed blankets are red; so, too, are the window curtains, and if the lamp shines too brightly there is a red hood which you can draw over it. The prices for berths are about double what they are in this country.

Contracting.

Steel Forgings.—General Benet, Chief of Ordnance, U. S. Army, has advertised for steel forgings for twenty-five field guns, which he hopes to have completed and ready for service during the present year. Such good results have been attained with the single gun recently tested at Sandy Hook that he feels justified in going forward with the construction of these guns, which, as all army officers know, are greatly needed.

Iron and Steel Bridges.—Saul Samuel, Agent for New South Wales, 5 Westminster Chambers, S. W. London, advertises for proposals until June 1, 1885, for building a steel bridge, about 3,000 feet long and 40 feet in clear height above water, over the Hawkesbury River, in New South Wales. Bridge is for a double track railway.

Cutting Cape Cod.—The Massachusetts people exhibit a stern, dogged determination in their great enterprise of cutting a ship canal across Cape Cod from Buzzard's bay and Massachusetts bay. Dredging machines have been at work for two years cutting through the hard blue clay, and about half a mile of the seven miles has been dug. The canal is to be 200 feet wide and twenty-three feet deep. The dredge now at work cost $60,000. The canal will cost $7,000,000 but it will cheapen the delivery and cost of coal and save vessels from shipment on the outside cape. There is no federal subsidy helping this great work.

N. Y. Contracts.—The *City Record* of April 14th, contains proposals for building an addition to the "Tombs;" for building an Engine house on Tremont Ave.; for building eleven free, floating, bath-houses; for building a Lodging-house and Prison in E. 48th. Street.

Building Contracts.—Contracts for the walls of All Saints' Cathedral have been awarded to John Sneith, of Ithaca, N. Y., for $116,000. The contract calls for the erection of the walls of the Cathedral proper, without the towers, the vestry, cloister, &c. The contract also includes the building of twenty-four memorial pillars in the nave. Money enough is now pledged to build the eastern half, which, it is estimated, will cost $50,000. The construction of the western half depends upon whether sufficient money to warrant the undertaking shall be raised. About $60,000 is now pledged. The work of the eastern half, if that alone is built, is to be finished by November 1st. The walls are to be of Potsdam stone and brown stone.

Dredging.—Proposals for dredging the river and removing bars and other obstructions between the Lake Shore bridge and the new canal transfer lock, at Cleveland, O., and also in the old river bed, were received at the board of improvement's office, April 3rd. The following bids were made: For excavating per cubic yard, L. P. & J. A. Smith, 28 cents; W. J. Starkweather, 29 cents; William E. Rooney, 17 cents; Michael Kerr, and others, of Erie, Pa., 22 cents; Jesse Simms, 25 cents. For each hour in removing logs and like obstructions, the proposals of these five bidders were, respectively, $12, $11, $9, $8, and $8. Mr. Rooney, the lowest bidder, resides in Toledo.

Kansas City Contracts Let.—The following contracts were awarded March 30th, by the Public Improvement Committee and City Engineer W. B. Knight, of Kansas City, Mo.: Grading Pacific street from Tracy avenue to east end of Pacific street 14,800 cubic yards of embankment to N. H. Comstock & Co., at 23⅝c.; grading Fourth street from Broadway to Washington street 4,800 cubic yards excavation to James Crowley, at 21c. per cubic yard; grading Washington street from Fourth to Fifth streets 4,600 cubic yards excavation to James Crowley, at 21c. per cubic yard; grading Fifteenth street from Tracey avenue to Woodland avenue 9,000 cubic yards embankment to N. H. Comstock & Co., at 17⅛c. per cubic yard; constructing section No. 4 of sewer in district No. 108 was awarded to John Ryan, of Denver, Colo., at the following prices: 340 feet of 2 feet brick sewer, at $2.77 per lineal foot; 2,835 feet 18-inch vetrified clay pipe sewer, at $1.58 per foot; 2,120 feet of 15-inch pipe, at $1.28; 3,235 feet of 12-inch pipe sewer, at $1.18; 2,175 feet of 10-inch pipe sewer, at $1.12 per lineal foot; 27 receiving basins, at $80 each; 39 manholes, at $45 each; concrete, at $3.50 per cubic yard; lumber, $20 per M.; rock excavation, $4 per cubic yard; total, $20,846. The other bidders were John Shaw, $25,275; Robert Chambers, $23,019; C. E. Donnelly & Co., $22,505; Thomas Appleton, $26,040; Wm. Taylor, $23,415; J. D. Hackett, $28,473; W. H. Faulkner, $22,854; and Leo Felix, $24,634.

The two new English armor-clads to be built by contract are to have a displacement of 10,470 tons and 8,500 horse-power, a speed of 15½ knots and an armament of two 110-ton guns in a turret, with twelve six-inch breech-loaders on upper deck, twelve quick-firing guns, and twelve 1-inch Nordenfeldts on spar deck. The armor plating proposed is to be 18-inch on sides, 16-inch on bulkheads, 18-inch on redout and turret, 3-inch on decks, with a backing of 6-inch teak; the length between perpendiculars 340 feet, and a weight of hull of 6,850 tons. The new belted cruisers, for which tenders have recently been solicited, are to be considerably larger than the "Mersey" class, having an increase of 1,300 tons in the displacement, bringing it up to 5,000 tons. The hulls are to be of steel throughout. They will be broader in the beam by 10 feet, being 300 feet by 56 feet. The protective deck has been replaced by an armor belt 200 feet long, formed of 10-inch steel-faced armor with 6-inch backing, the ends are protected by an underwater belt, as in the *Mersey*, the part of the water-line not actually protected being very small. The engines are to be 7,500 h. p., with forced draught and closed stokehole. The armament consists of two 18-ton guns, one forward, with an arc of training extending all around the bow to 50 degrees abaft either beam, and one aft through a similar sweep round the stern; twelve 4-ton guns, six machine guns, and a torpedo equipment with above and below water discharge. They will be manned with about 350 officers and men, and will be undoubtedly very formidable vessels; but as their speed is not expected to be more than 16 knots they have one very weak point indeed.

Salem, Mass., Contracts.—The contracts for building a canal, filling the North river and dredging the channel below North bridge have been awarded. The proposals advertised for were first for the entire pile and timber work for canal and bulkhead and the sewers and drains. Second, for the entire dredging above and below North bridge. Third, for the entire gravel filling in the basin and in Smith's dock, the prices to cover all expenses incident to the completion of the work in full comformity with the specifications. A bond in the sum of $10,000 will be required and the con-

tracts are to be signed within seven days from the date of notification of the award. In case the contract is not accepted by the bidder he forfeits the sum of $500. The canal is to be about 2,000 feet in length, 60 feet wide, with oak piles, hard pine and spruce plank, three inches thick, with hard pine cap. The dredging above North bridge will be 70 feet wide, and about 4 feet deep and below the bridge 50 feet wide on the bottom and 70 feet on the top, with a average depth of 4 feet for a distance of 3,600 feet. There is also about 30,000 square feet of dredging at the wharves just below the bridge at an average depth of three feet. The dredging above North bridge is to be commenced immediately after the signing of the contract and be completed within five weeks. It will require 1,600 oak piles from 27 to 30 feet long, and about 200,000 feet of lumber. The filling will require 215,000 cubic yards of gravel. No sub-contracting is allowed and the work will be done under the inspection and direction of Civil Engineer Charles A. Putnam. The bids were as follows for the entire job: Joseph Ross, of Ipswich, $96,125; Hamilton S. Balcomb, Salem, $103,113; J. H. Davis & Co., $104,916; W. A. Norton and Joshua Brown, Salem, $107,150; Mack Brothers, Salem, $107,800; Parsons & Peterson, Salem, $108,168; Parker & Sylvester, $100,910; Patrick P. Pinder, $114,879; W. A. Kenrick, $115,900; Conrad Gaul, Danvers, $116,997; W. H. Ward, $123,600. For the bulkhead separate the bills were: Norton & Brown, $20,000; Hamilton & Balcomb, $19,800; Ryan, Hayes & Co., $22,513; Alexander McInnis, $21,638; W. A. Kenrick, $20,152. For the filling separate: Norton & Brown, $75,250; Mack Brothers $76,400; Charles Linehan, $72,025; Moulton & Mahoney $70,412 50; W. A. Kenrick $83,850; Boston & Maine railroad, $86,000. The contract was awarded to Joseph Ross of Ipswich, who, it is stated, obtained a lower figure from the railroad on the filling than the others did.

Index to Periodical Literature.

Bridges, Pittsburg Junction R. R.—*Bridges of Pittsburg Railroad Junction.* Illustrations of main channel spans, with details and description. *R. R. Gazette*, Ap. 3, 1885, p. 211.

Bridge, Storm-King.—*The Storm-King Bridge over the Hudson.* A general description, with elevation, of the proposed cantilever bridge near Newburg. The longest span is 1,000 feet, and two are of 600 feet each. The towers are of iron or steel, or masonry piers. *National Car Builder*, Ap. 1885, pp. 48 and 49.

Cars, Parlor.—*Parlor Car Construction—Old Colony and Boston and Lowell Railroads.* Engravings illustrating the floor plan, inside finish, and trucks; the trucks being shown in detail, with dimensions. *National Car Builder.* Ap. 1885, pp. 44 and 45.

Harbor Capacity.—*Determination of the Anchorage Capacity of Harbors.*—The formulas and rules of Stevenson, Mitchell and others, quoted by the writer, do not provide for vessels sweeping over portions of each other's anchorage spaces. The rules given by the writer make this allowance. The article is very interesting and is accompanied by illustrations, and a chart showing application of rules. Report of Major C. W. Raymond. *Ann. Rep. Chief of Engineers, U. S. A.*, 1884; Part 1, App. B. pp 579 to 587.

Iron and Steel. Strength Of.—*On the Modifications of Tensile Strength and Ductility which Iron and Steel undergo when heated to between Certain Temperatures.*—This article has special application to the use of these metals in boilers, and gives the result of trials with various grades of iron and steel at various temperatures, made by different experimenters. Trans. from the French of E. Comst by Ch. Eng. Sherwood U. S. N. *Jour. Franklin Inst.* Ap. 1885, pp 257 to 266.

Lubricants.—*On the Real Value of Lubricants and on the Correct method of Comparing Prices.*—A general formula is given, involving the cost of the Lubricant, the quantity used, the total cost of power per H. P. per hour and the amount of power used in overcoming friction of lubricated surfaces, from which is obtained the total expense per hour. Several examples given by way of application. By R. H. Thurston *Trans. Am. Soc. Civil Engineers.*, cccvi. Dec. 1884, pp. 76 to 491.

Pile-driving, Water Jet.—*Pile-driving in sandy soils* A valuable report on driving piles with the water jet, and with steam-hammer. A great many observations were made on the time employed in the various operations incident to sinking the piles, by both methods, and the results are given in tabular form and graphically, and carefully analyzed. The machines are described, and each operation is narrated in detail. The results by the two kinds of machines are compared. By Lieut. F. V. Abbott. *An. Rep. ch. of Engineers U. S. A.* 1885, Part 2, pp. 1249 to 1261.

Pile-driving Water Jet.—*Pile driving.* A carefully prepared and elaborate report on the driving of piles by the water jet, in the Miss. River, (supplementing the report indexed above.) The cost of driving by this method is given in detail, being the average of many thousands of piles. The results are shown graphically and in tabular form. By Lieut. F. V. Abbott. *An. Rep. Ch of Engineers, U. S. A.* 1884, Part 1, pp. 1505 to 1521.

Port-Reunion.—*Travaux du Port de la Réunion.* Its construction is described fully and illustrated in great details, with illustrations of the machinery used. The walls of the inner basins are wooden constructions supported on iron screw-piles. The jetties are built of concrete blocks, handled and set in place by a crane operated on a track. The account of this construction is very interesting. By M. M. Joubert et Fleury. *Mem. de la Société des Ingenieurs Civils.* November, 1884, pp. 484 to 506.

Railroads, Belgians. *Chemins de Fer Belges.* An official report on the methods for assuring security of circulation on the railways, by various methods of blocking, signaling, switching, etc., with conclusions: very fully illustrated. The writers were sent by the French Government on a mission to study the railways of England, Germany, Belgium and Holland, and this is one of their reports. By M. M Brame and Worms de Romilly. *Ann. des Ponts et Chaussees*, Jany. 85, pp 5 to 78.

Railroads, Narrow Gauge. *Advantages de la Voie Etroite.* An elaborate study of the advantages of a narrow gange over a broad one, with special reference to local railways. The advantages and disadvantages are stated and weighed, the conclusions being favorable to the narrow gauge projects. By Auguste Moreau. *Memoire de la Société des Ingénieurs Civils.* Dec., 1884, pp. 557 to 614.

Railroad Speed. *Modern Railroad Facilities.* A summary of the fastest trains in the world, carefully collated from time-tables and other sources, arrayed in tables, with some account of the lines on which the trains are run. By Wm. B. Le Van. *Jour. of Franklin Inst.* Apr. 1885, pp. 267 to 279.

Rapid Transit, Paris. *Chemin de Fer Métropolitan dans Paris.* A detailed description of the plan for an underground road proposed by the author, with statement of probable cost, traffic and receipts. Illustrated with a cross section plan of Paris, showing route and profiles. By M. Hoag, Eng. in Chief of the "Ponts et Chaussées." *Mem. Soc. des Ingénieurs Civils.* Dec. 1884, pp. 541 to 556.

River Conservation.—*Conservation of the Connecticut River.* A report on the physical features of that portion of it within the State of Connecticut. Peculiarities in its course; serpentines, cut-offs, etc.; remedies to be applied; freshets not caused by cutting away forests; the necessity of further surveys and studies. By Clemens Herchel *Ann. Rep. Harbor & Land Commissioners of Conn.* 1884. pp. 39 47.

Sewerage Potsdam, Germany.—*Proposed Sewerage Scheme for Potsdam, Germany.* The "Shone" separate system for household waste and excrements only is proposed. The project includes schemes for the complete purification of sewage before its discharge into the river, either by downward filtration or by atmospheric oxidation. *San. Engineer.* Ap. 2nd, 1885, p. 374.

Market Report of Engineering Materials.

New York, April 16, 1885.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.		
Angles		2.c. @ 2.2c.
Tee		2.25c. @
Beams and channels		3.0c. @ 3.5c.
Tank		2.1c. @ 2.15c.
Shell		2¼c. @
Steel plates, Tank		2¼c. @ 3c.
WROUGHT-IRON PIPE, PITTSBURGH.		
Butt welded, black	Discount	50
" " galvanized	"	40
Lap welded black	"	50
" " Galvanized	"	37½
Boiler tubes	"	60
RAILS.		
Steel (large lots at mill)		$26.50 @ 27.00
Old rails		17.25 @ 17.50
Old rails, steel		17 @ 18
R. R. spikes		1.8 @ 1.9c
R. R. splice-plates		1.65c. @ 1.75c.
R. R. Track Bolts		2.6c. @ 3c.
Barb-wire fencing, galvanized		4¾c. @ 5¼c.
" " painted		3¾c. @ 4¼c.
Corrugated iron		
Nails		
Iron		2.25
Steel		2.35

METALS.

COPPER.		
Lake Superior		10 8 @ .11
Other Brands		10¼ @ 10¾
LEAD.		
Com. Domestic		3.60 @ 3.70
Lead Pipe		.06¾
Tin-Lined Lead Pipe		.15
Sheet Lead		.06¾
ZINC.		
Sheet		5.00 @ 5.20

BRICK.

(Cargoes afloat)		
Haverstraw 1st	per M.	$5.75 @ 6.25
" 2nd	"	5.62 @ 5.87
Fishkill		4.75 @ 5.50
Up-River		
Jerseys		5.25 @
Long Island		
" pale		
FRONTS.		
Croton red		14.00 @
" dark		14.00 @
" brown		12.00 @
Philadelphia pressed		22.50 @ 23.00
Trenton "		22.50 @ 23.00
Baltimore "		37.00 @ 41.00
Buff "		33.00 @ 35.00
Enameled English		65.00 @ 130.00
" American		85.00 @ 120.00
Fire brick		25.00 @ 40.00

CEMENT.

PORTLAND.		
Gibb's English	400 lbs. per bbl	2.75 @ 2.90
K. B. & S. "	"	2.85 @ 3.00
Burham "	"	2.70 @ 2.85
Keene's fine "	"	9.50 @ 9.75
" course "	"	5.25 @ 5.75
Roman		2.75 @ 3.50
Langerdorfer German	"	2.90 @ 2 65
Dyckerhoff, "	"	2.60 @ 2.65
Stettiner "	"	2.60 @ 2.65
Alsen, "	"	2.55 @ 2.60
Fieve "	"	2.40 @ 2.50
Saylor's American		2.15 @ 2.40
ROSENDALE cements		0.90 @ 1.10

LIME.

Rockland common	per bbl	1.00
" finishing	"	1.20
Glensfalls, common	"	.85
" finishing	"	1.05 @ 1.10
Kingston, ground		0.95

STONE.

Cargo rates at New York.

Amherst freestone, No. 1	per cub. ft.	0.90 @ 95
" " No. 2	"	0.75 @ 0.80
" " light drab	"	0.80 @ 0.95
Berlin " in rough	"	0.75 @ 1.00
Berea "	"	0.75 @ 1.00
Brownstone, Portland, Ct.	"	1.00 @ 1.30
" Belleville, N. J.	"	0.75 @ 1.25
Granite, rough		0.60 @ 1.25
Common building stone per load		2.00 @ 3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.		0.40 @ 3.00

SLATE.

Purple roofing	per square	6.00 @ 7.00
Green	"	6.00 @ 7.00
Red	"	15.00
Black Penna. (at New York)	"	4.50 @ 5.00

LUMBER.

PINE, Common box	per M.	18.00 @ 20.00
Good	"	
Tally plank, 1¼ in	each.	.44 @ .50
Tally boards, dressed com.	"	.28 @ .30
SPRUCE, Boards dressed	"	.25 @ .28
Plank, 1¼ in	"	.28 @ .30
" 2 in.	"	.38 @ .40
" 2 in. dressed	"	.43 @ .45
Timber	per M.	20.00 @ 22.00
HEMLOCK, Boards	each.	.18 @ .20
Joist, 2½ × 4 to 4 × 6 in		.17 @ .44
OAK	per M.	55.00 @ 65.00
CYPRESS 1, 1¼, 2 and 2½ in	"	35.00 @ 40.00
YELLOW PINE, Girders	"	26.00 @ 35.00
Dressed flooring	"	30.00 @ 40.00
SHINGLES, Extra shaved pine, 16in.	"	
" sawed 18 in.	"	4.50 @ 5.00
LATH, Cargo rate	"	2.40 @ 2.50

PAINT.

Lead, white, American dry	per lb	.04¾ @ .05
" " in oil pure	"	.05½ @ .05¾
English, B. B. in oil	"	.08¾ @ .08¾
Red, American	"	.05¾ @ .05¾
Litharge	"	.05 @ .05¼
Venetian red, American	"	.01 @ .01¼
Indian red	"	.05 @ .10
Vermillion, American lead	"	.11 @ .11¾
Paris green	"	.15 @ .19
Umber, Amer. raw and powdered	per lb.	.01¾ @ .01½
Drop black, Amer.	"	.08 @ .12
" "	"	.09 @ .11¾
Chrome green	"	.05 @ .15
Oxide zinc, American	"	.03¾ @ .04
" French	"	.06¼ @ .06½

THE TURNPIKE is an institution which has disappeared from most of the counties in the State, and yet Lancaster, Penna., has twenty-four such companies within her limit, most of them doing a profitable business, and fifteen of them leading directly into the city of Lancaster. The paid up capital represented in these fifteen roads is 470,400, while the market value is much more.